



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

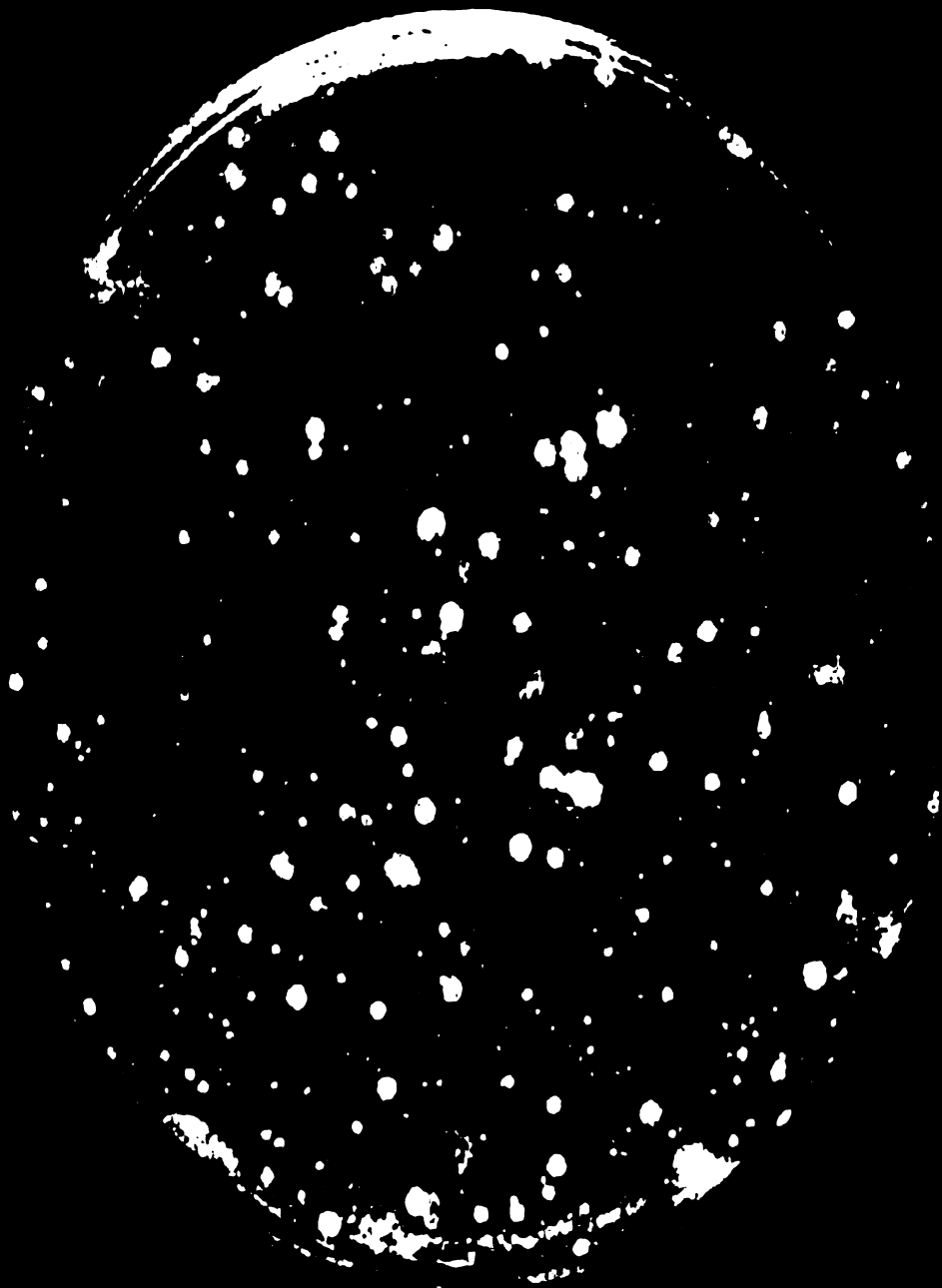
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

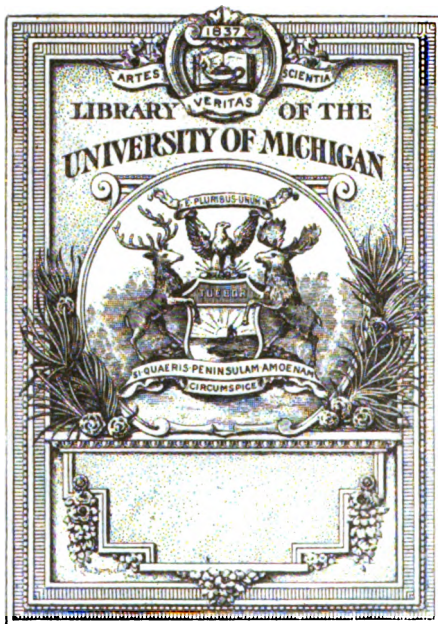


Circular

United States. Bureau of Animal Industry

25,

2,500,000 - 2,500,000



SF
11
A35

636,073
258
B95c

UNIVERSITY LIBRARY,
UNIV. OF MICH.
NOV 18 1909

Issued October 12, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 151.
A. D. MELVIN, CHIEF OF BUREAU.

COMPETITIVE EXHIBITIONS OF MILK AND CREAM,

WITH REPORT OF AN EXHIBITION HELD AT
PITTSBURG, PA., IN COOPERATION WITH
THE PITTSBURG CHAMBER OF COMMERCE.

BY

C. B. LANE AND IVAN C. WELD,
Of the Dairy Division.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 20, 1909.

SIR: I have the honor to transmit herewith and to recommend for publication as a circular of this Bureau a manuscript entitled "Competitive Exhibitions of Milk and Cream, with Report of an Exhibition held at Pittsburg, Pa., in Cooperation with the Pittsburg Chamber of Commerce," by C. B. Lane, senior dairyman, and Ivan C. Weld, assistant dairyman, of the Dairy Division of this Bureau.

The first competitive exhibition of milk and cream was held under the direction of the Dairy Division in connection with the National Dairy Show at Chicago in 1906. Since then a number of others have been planned and carried out in different parts of the country in cooperation with local authorities. The present paper deals more particularly with one held in Pittsburg, Pa., under the auspices of the Chamber of Commerce of that city.

These public exhibitions and the meetings held in connection therewith have proved to be of great educational value to the dairy interests of the country, and they have given a decided impetus to the movement for the improvement of the milk supply, especially in the large cities.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
The first national milk and cream exhibition.....	5
State exhibitions.....	5
The first city milk exhibition.....	6
The exhibition at Pittsburg, Pa.....	6
Conditions of entering.....	7
Judges and prizes.....	8
Method of scoring the milk and cream.....	8
Details of score made by each entry.....	10
Comments on the scores.....	12
The dairy farm competition.....	13
Score card for dairy farms.....	13
Details of the scoring.....	15
Principal defects found.....	15
List of prize winners.....	15
Addresses and papers.....	16
Opening remarks by C. B. Lane.....	16
Remarks by President Smith of the Chamber of Commerce.....	17
Response by John W. Quivey for milk producers.....	17
The essentials for the production of wholesome market milk. By H. E. Van Norman.....	18
Legislation in reference to the milk supply of the city of Pittsburg. By J. C. McNeil.....	20
Dairy contests. By C. B. Lane.....	23
Tuberculosis in cattle. By Leonard Pearson.....	25
The scoring of milk and cream. By Ivan C. Weld.....	26
Profits of a dairy farm. By Oscar Erf.....	29
The relation of the health bureau to the dairyman. By J. F. Edwards.....	32
List of exhibitions.....	34
Revised score card for dairy farms.....	35

COMPETITIVE EXHIBITIONS OF MILK AND CREAM.

THE FIRST NATIONAL MILK AND CREAM EXHIBITION.

The first public milk and cream exhibition for prizes in this country was held in connection with the National Dairy Show in Chicago, under the direction of the Dairy Division, Bureau of Animal Industry, United States Department of Agriculture, February 15-24, 1906. The objects were, first, educational; second, to determine the possibilities in the handling and keeping of milk and cream produced under sanitary conditions and kept cold; and third, to test a score card for rating fairly and accurately this class of dairy products.

Much interest was manifested from the beginning, exhibits being sent from thirteen different States. The results were most gratifying, one of the most striking being the demonstration of the fact that clean milk, held at a low temperature, could be shipped a thousand miles across the country and kept sweet for a period of over five weeks. It was further demonstrated that milk and cream could be scored with reasonable accuracy for flavor, chemical qualities, keeping qualities, etc., on the score-card plan as applied to butter and other products.

A full report of this exhibition was given in Bulletin 87 of the Bureau of Animal Industry.

STATE EXHIBITIONS.

Since the national contest was held several States have had similar exhibits in connection with the State dairy association meetings. Among them may be mentioned New Hampshire, Pennsylvania, Maine, Vermont, Connecticut, Illinois, Kentucky, Michigan, Ohio, and Massachusetts.

These contests have proved of great benefit to dairymen, particularly in pointing out defects in the product and in the styles of bottles used, and suggesting remedies for the same. One of the most common defects in milk, and one which can be readily seen, is the foreign matter in the bottom of the bottle, consisting usually of particles of manure, hair, bedding, etc. This indicates careless and uncleanly methods in production and handling. Another common defect is found in off-flavored milk, and this may be due to a variety of causes, as (1) strong-flavored feeds, such as turnips, garlic, etc.; (2) feeding certain feeds to excess, as, for example, silage; (3) odors of silage or manure in the stable; (4) particles of manure and dirt getting into the milk, and (5) not properly rinsing the bottles after

using washing powders. Dairymen as a rule have been quick to see these defects when pointed out and to appreciate the importance from a business standpoint of producing milk as nearly perfect as possible.

THE FIRST CITY MILK EXHIBITION.

In view of the success of the national exhibition and those of several States, it was thought that the plan might be applicable to cities. Steps were therefore taken to give it a trial. The city of Cleveland, Ohio, had already adopted the Dairy Division score card for rating dairy farms, and as this city was making a special effort to improve conditions in the dairies and the quality of its milk supply, arrangements were made with the Chamber of Commerce to conduct a competitive exhibition under its auspices. This organization looked after the printing of the entry blanks, score cards, and letters to dairymen, and mailing the same; and furnished the hall for the meetings and the laboratory space for the chemical and bacteriological work. It also offered medals for the best exhibits of milk and cream, and the most sanitary dairy farms, and furnished two of the judges. The Dairy Division performed the chemical and bacteriological work and supplied the other two judges. Some 400 producers of milk for the Cleveland market were present at an all-day conference, when addresses on timely subjects were given by representatives from the Department of Agriculture and the Cleveland Chamber of Commerce. Many questions were asked by the dairymen present, which resulted in valuable discussions.

There were three classes in the contest, as follows:

Class I. Market milk (raw): This comprised all milk not "certified" or sold under any guaranty as to its quality. A very large percentage of the milk supplied to our cities is of this character. It was specified that the milk in this class must not be pasteurized or contain any preservatives.

Class II. Market cream (raw): It was specified that this product should be sweet, unpasteurized, and free from preservatives.

Class III. Dairy farms: All dairymen having exhibits of milk or cream in the above classes were permitted to enter the dairy-farm contest. These farms were visited by the judges and scored on the basis of a score card (see page 13). The results of this contest were published as Circular 117 of the Bureau of Animal Industry.

The first contest in Cleveland proved so valuable to the dairymen that a second contest was held March 7, 1908, on a similar basis. The dairy meeting in connection with it was even better attended than the first.

THE EXHIBITION AT PITTSBURG, PA.

A very successful exhibition was held in Pittsburg, Pa., in October, 1908, under the auspices of the Chamber of Commerce of that city,

and in cooperation with the Dairy Division of the Bureau of Animal Industry. This proved to be the largest and most enthusiastic exhibition so far held. There were 50 entries of milk and 11 entries of cream, while 20 dairymen entered the dairy-farm competition held at the same time. There were approximately 400 dairymen present at the meetings. This contest was conducted in practically the same manner as those held at Cleveland, except that some improvements were made in the entry blanks and score cards. This circular has therefore been prepared with the idea of presenting the best methods of conducting contests of this character.

CONDITIONS OF ENTERING.

The conditions of entry are set forth in the following entry blank, which was sent to dairymen with a circular letter inviting them to enter the competition and attend the meetings.

[Chamber of Commerce of Pittsburg. Dairy meeting and milk and cream contest, Pittsburg, Pa., Thursday, October 22, 1908, under the direction of the Dairy Division, Bureau of Animal Industry, U. S. Department of Agriculture.]

OFFICIAL ENTRY BLANK.

CLASS I. MARKET MILK (RAW).

P. O. Address: _____,
Date: _____, 1908.

C. B. LANE,

Assistant Chief, Dairy Division.

Please enter for me 4 quarts of milk to compete for prizes offered by the Chamber of Commerce of Pittsburg, October 22, 1908, in accordance with the conditions herein prescribed.

Rules: (1) Exhibitors are allowed to make only one entry in each class. This must include in Class I, 4 quarts of milk in 1-quart bottles, placed in a box suitable for shipping. (2) The milk to be the property of the United States Department of Agriculture. (3) Every exhibitor is required to fill out and sign the following certificate:

I, _____, hereby certify that the milk entered in this competition is a fair sample of the product sold by me, that it is free from preservatives, and that it has not been pasteurized or sterilized.

(Signed) _____,
(Proprietor) _____.

HOW TO COMPETE.

Milk to compete for prizes must be sent by express or otherwise, from station nearest the producer, direct to C. B. Lane, assistant chief, Dairy Division, care Pittsburg Chamber of Commerce, Pittsburg, Pa. Express charges on exhibits must be prepaid to destination.

The package should be plainly addressed on outside; a card should also be tacked on box inside, giving plainly sender's name and address, so as to avoid mistakes in identifying packages.

In order that the milk entered by the exhibitors may be of the same age when scored, it is hereby specified that it shall be drawn from the cow Friday, October 16, 1908, and shipped by express not later than the day following. This is necessary in order that the sample may be received in ample time for testing and scoring, which requires three days.

A representative of the Department of Agriculture will be on hand to take charge of the milk on its arrival and will see that it is properly cared for.

Only these official entry blanks will be accepted.

QUESTIONS TO BE ANSWERED BY EXHIBITORS.

1. Give date and hour when this milk was drawn from the cow: ———.
2. Give place, date, and hour at which this milk was delivered to the express company or otherwise shipped: ———.
3. Does this milk fairly represent the average product of your herd in quality and cleanliness? ———.
4. How was the milk treated from the time it was drawn from the cow until shipped? ———.
5. Do you wish to compete for the dairy-farm prize? ———.

(Only those dairymen entering in the milk or cream contest will be entitled to have their dairy farms scored for the dairy-farm prizes.)

(Signed) ———, ———.

JUDGES AND PRIZES.

It was arranged to give the products exhibited, as well as the dairy farms, in the contest the most careful examination possible, so that the final results would be beyond question, and it may be said that the dairymen generally expressed themselves as well pleased with the absolute fairness with which the contest was conducted. The judges were C. B. Lane and Ivan C. Weld, from the Dairy Division, and Doctors James F. Edwards and J. C. McNeil, from the health department of Pittsburg.

The Chamber of Commerce of Pittsburg offered very attractive gold and silver medals to the dairymen securing the highest scores. This feature increased the interest and stimulated keen competition. Medals were also awarded for the dairy farms having the best sanitary condition and equipment.

METHOD OF SCORING THE MILK AND CREAM.

The scoring was done on the basis of score cards similar to those used in previous contests. The judges experienced but little difficulty in this work; in fact, it was demonstrated that milk and cream can be graded as accurately as butter or cheese by the use of the score card, although the application of the system to milk and cream is comparatively new.

All the milk and cream entered in this contest was produced October 16 and shipped to a cold-storage house in Pittsburg. The scoring was done October 20, when the product was four days old. The score cards used in this contest are presented herewith.

[Front of score card.]

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SCORE CARD FOR MARKET MILK.

Exhibitor: _____.

Address: _____.

NUMERICAL SCORE.

Flavor, 40.	Composition, 25.	Bacteria, 20.	Acidity, 5.	Appearance of package and contents, 10.	Perfect score, 100.
					Judge's score.

DESCRIPTIVE SCORE.

Flavor.	Composition.	Bacteria.	Acidity.	Package and contents.
Excellent.	Perfect.	Perfect.	Perfect.	Perfect.
Good.	Fat.....per cent.	Total.....	 per cent.	Foreign matter.
Fair.	Solids not fat.	Liquefiers.....		Metal parts.
Bad.	 per cent.			Unattractive.
.....				
Flat.				
Bitter.				
Weedy.				
Garlic.				
Slime.				
Smothered.				
Manure.				
Other taints.				
.....				
.....				

Remarks: _____.

Date: _____.

_____, _____, Judge.

[Reverse side of score card.]

DIRECTIONS FOR SCORING.

FLAVOR.

If rich, sweet, clean, and pleasant flavor and odor, score perfect (40). Deduct for objectionable flavors and odors according to conditions found.

COMPOSITION.

If 3.25 per cent fat or above and 8.5 per cent solids not fat or above, score perfect (25). Deduct 1 point for each one-fourth per cent fat below 3.25 and 1 point for each one-fourth per cent solids not fat below 8.5.

BACTERIA.

Less than 10,000 per cubic centimeter.....	perfect..	20
Over 10,000 and less than 25,000 per cubic centimeter.....		19
Over 25,000 and less than 50,000 per cubic centimeter.....		18
Over 50,000 and less than 75,000 per cubic centimeter.....		17
Over 75,000 and less than 100,000 per cubic centimeter.....		16
Deduct one point for each 25,000 above 100,000.		

When an unusually large number of liquefying bacteria are present, further deduction should be made according to conditions found.

ACIDITY.

If 0.2 per cent or below, score perfect (5). Deduct 1 point for each 0.01 per cent above 0.2. (If Mann's test is used, discontinue adding indicator on first appearance of a pink color.)

APPEARANCE OF PACKAGE AND CONTENTS.

If package is clean, free from metal parts, and no foreign matter can be detected in the contents, score perfect (10). Make deductions according to conditions found.

The score card for market cream was identical with that for market milk, with the following exceptions: (1) The terms "lumpy" and "frothy" were added to the first column of the descriptive score, and (2) the directions for scoring "composition" were:

If 20 per cent or above, score perfect (25). Deduct 1 point for each one-half per cent fat below 20.

DETAILS OF SCORE MADE BY EACH ENTRY.

The composition, condition, and numerical scores of the entries of market milk and cream in the Pittsburg contest are given in the following tables:

TABLE 1.—*Composition and condition of entries of market milk and cream.*

MILK.

Sample No.	Fat.	Solids not fat.	Acidity.	Total bacteria per cubic centimeter.	Appearance of package.	Remarks.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>			
1.....	4.6	8.17	0.14	85,000	Much sediment.....	
2.....	3.4	8.68	.18	12,300	do.....	
3.....	4.0	8.05	.18	17,500	do.....	
4.....	7.0	7.9	.21	2,400,000	Slight sediment.....	
5.....	5.0	8.5	.22	1,000,000	do.....	
6.....	4.6	8.42	.18	4,000	do.....	Gold medal.
7.....	3.1	8.37	.16	2,200	do.....	
8.....	4.4	8.13	.15	25,700	do.....	
9.....	3.5	8.45	.14	470,000	do.....	
10.....	3.6	7.97	.16	8,700	Much sediment.....	
11.....	3.5	8.20	.15	5,000	Slight sediment.....	
12.....	3.4	8.18	.10	202,000	do.....	
13.....	4.0	8.05	.17	27,600	Clean.....	
14.....	4.6	9.92	.14	100,000	do.....	
15.....	5.0	9.25	.13	24,700	do.....	
16.....	3.1	8.24	.18	37,000	Slight sediment.....	
17.....	4.0	8.42	.15	495,000	Much sediment.....	
18.....	3.4	8.43	.25	912,000	Slight sediment.....	
19.....	4.0	9.05	.16	14,500	Clean.....	Honorable mention.
20.....	5.0	8.87	.14	1,500	do.....	Do.
21.....	3.4	8.43	.15	8,000	Slight sediment.....	Do.
22.....	4.0	9.3	.14	260,000	do.....	
23.....	4.4	8.75	.16	87,000	Much sediment.....	
24.....	3.4	8.43	.16	300,000	do.....	
25.....	3.5	8.32	.14	8,400	do.....	
26.....	4.0	8.17	.16	40,000	Clean.....	Do.
27.....	3.4	8.68	.17	8,000	do.....	Silver medal.
28.....	3.0	8.22	.16	5,500	Much sediment.....	
29.....	3.0	7.47	.14	205,000	do.....	
30.....	3.3	8.28	.16	8,200	do.....	
31.....	3.4	8.48	.14	4,600	Slight sediment.....	
32.....	3.4	8.3	.33	3,500,000	Much sediment.....	
33.....	4.0	8.67	.13	650,000	do.....	
34.....	4.0	8.3	.17	5,300	do.....	
35.....	4.0	8.3	.16	49,000	do.....	
36.....	4.2	8.59	.17	21,000	Slight sediment.....	
37.....	3.6	8.97	.17	6,500	do.....	Honorable mention.

TABLE 1.—Composition and condition of entries of market milk and cream—Continued.

MILK—Continued.

Sample No.	Fat.	Solids not fat.	Acidity.	Total bacteria per cubic centimeter.	Appearance of package.	Remarks.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>			
38.....	3.6	8.09	0.14	25,000	Slight sediment.....	Honorable mention.
39.....	3.2	8.39	.14	537,000	Much sediment.....	
40.....	3.6	8.47	.16	15,000	Clean.....	
41.....	3.8	7.2	.16	11,000	Much sediment.....	
42.....	3.0	8.1	.14	10,000	do.....	
43.....	4.0	8.55	.16	3,400	do.....	
44.....	3.2	8.4	.18	610,000	do.....	
45.....	3.1	9.12	.17	1,400	do.....	
46.....	4.0	8.17	.17	445,000	Slight sediment.....	
47.....	3.8	8.51	.17	180,000	do.....	
48.....	3.8	7.97	.15	3,300	do.....	
49.....	3.8	8.26	.16	1,310,000	do.....	
50.....	3.4	8.18	.15	650,000	Much sediment.....	

CREAM.

101.....	36.0		0.12	150,000	Much sediment.....	Silver medal. Gold medal.
102.....	30.0	.....	.27	2,500,000	Slight sediment.....	
103.....	30.0	.....	.16	570,000	do.....	
104.....	18.0	.....	.15	750,000	Much sediment.....	
105.....	30.0	.....	.19	8,640,000	do.....	
106.....	34.0	.....	.15	78,000	Clean.....	
107.....	30.0	.....	.14	37,000	do.....	
108.....	36.0	.....	.15	296,000	Slight sediment.....	
109.....	30.0	.....	.32	(a)	do.....	
110.....	28.0	.....	.15	(a)	do.....	
111.....	36.0	.....	.19	(a)	Much sediment.....	

a These entries arrived too late for the bacterial count.

TABLE 2.—Numerical scores of the milk and cream.

MILK.

Sample No.	Flavor (perfect 40 points).	Composition (perfect 25 points).	Bacteria (perfect 20 points).	Appearance (perfect 10 points).	Acidity (perfect 5 points).	Total score (perfect 100 points).
1.....	34.5	25	16	8.5	5	89.0
2.....	34.0	25	19	6.0	5	89.0
3.....	33.0	25	19	9.0	5	91.0
4.....	33.5	25	0	9.5	4	72.0
5.....	33.0	25	0	9.5	3	70.5
6.....	36.5	25	20	9.0	5	95.5
7.....	33.5	24	20	9.5	5	92.0
8.....	33.5	25	18	9.5	5	91.0
9.....	35.5	24	1	9.5	5	75.0
10.....	34.0	23	20	8.5	5	90.5
11.....	35.0	24	20	9.5	5	93.5
12.....	32.5	24	11	9.5	5	82.0
13.....	37.0	25	18	10.0	5	95.0
14.....	36.0	25	15	10.0	5	91.0
15.....	34.0	25	19	10.0	5	93.0
16.....	35.0	24	18	9.5	5	91.5
17.....	34.5	25	0	8.5	5	73.0
18.....	30.0	24	0	9.5	0	63.5
19.....	35.0	25	19	10.0	5	94.0
20.....	34.0	25	20	10.0	5	94.0
21.....	35.5	24	20	9.5	5	94.0
22.....	31.0	25	9	9.5	5	79.5
23.....	34.5	25	16	9.0	5	89.5
24.....	35.0	24	7	9.0	5	80.0
25.....	33.5	24	20	9.0	5	91.5
26.....	36.0	25	18	10.0	5	94.0
27.....	35.25	25	20	10.0	5	95.25
28.....	36.5	23	20	9.0	5	93.5
29.....	33.0	20	11	9.0	5	78.0

TABLE 2.—Numerical scores of the milk and cream—Continued.

MILK—Continued.

Sample No.	Flavor (perfect 40 points).	Composition (perfect 25 points).	Bacteria (perfect 20 points).	Appearance (perfect 10 points).	Acidity (perfect 5 points).	Total score (perfect 100 points).
30.....	33.5	24	20	8.0	5	90.5
31.....	34.0	24	20	9.5	5	92.5
32.....	25.0	24	0	9.0	0	58.0
33.....	25.0	25	0	7.0	5	62.0
34.....	33.5	25	20	9.0	5	92.5
35.....	34.0	25	18	9.0	5	91.0
36.....	33.0	25	19	9.5	5	91.5
37.....	35.0	25	20	9.5	5	94.5
38.....	35.5	23	18	9.5	5	91.0
39.....	33.0	24	0	7.5	5	69.5
40.....	36.0	25	19	10.0	5	95.0
41.....	35.0	20	19	8.0	5	87.0
42.....	36.0	22	19	8.5	5	90.5
43.....	35.0	25	20	7.5	5	92.5
44.....	30.0	24	0	0	5	59.0
45.....	36.0	24	20	7.5	5	92.5
46.....	35.0	25	2	9.5	5	76.5
47.....	30.0	25	13	9.5	5	82.5
48.....	35.5	23	20	9.5	5	93.0
49.....	30.0	25	0	9.5	5	69.5
50.....	35.0	23	0	7.5	5	70.5

CREAM.

101.....	36.5	25	13	8.5	5	88.0
102.....	28.0	25	0	9.5	0	62.5
103.....	30.0	25	0	9.5	5	69.5
104.....	33.0	21	0	8.0	5	67.0
105.....	30.0	25	0	9.0	5	69.0
106.....	34.0	25	16	10.0	5	90.0
107.....	24.0	25	18	10.0	5	92.0
108.....	36.5	25	8	9.5	5	84.0
109.....	30.0	25	(a)	9.5	5	(a)
110.....	36.0	25	(a)	9.5	5	(a)
111.....	37.0	25	(a)	9.0	5	(a)

* These entries arrived too late for competition.

COMMENTS ON THE SCORES.

With the exception of a few samples the flavor of the milk and cream was very good. A few samples suggested a flavor of the cow stable and unclean utensils and a few had a distinct silage flavor. The lowest score for flavor of milk was 25 points; the highest, 37; the lowest score for flavor of cream was 28 points, and the highest 37.

The percentage of fat in the milk averaged 3.8, the lowest being 3 and the highest 7. The percentage of fat in the cream samples varied from 18 to 36. The lowest percentage of solids not fat was 7.20 and the highest 9.12. With but few exceptions the milk and cream exhibited did not exceed the required standard for acidity, which was 0.2 per cent. The lowest percentage was 0.13 and the highest 0.33.

The number of bacteria per cubic centimeter found in the different milk samples varied from 1,400 to 3,500,000. Sixteen of the 50 samples of milk contained less than 10,000 bacteria to the cubic

centimeter, a number small enough to meet the requirements for certified milk. The lowest number of bacteria found in the cream was 37,000 per cubic centimeter and the highest 8,640,000.

Perhaps the greatest criticism of the exhibits of milk and cream as a whole was the deposit of sediment or dirt in the bottom of the bottles. Only 8 samples of milk and 2 samples of cream were clean.

Of the 58 samples of milk competing 31 scored 90 or above.

THE DAIRY FARM COMPETITION.

This feature proved to be of great interest and practical value. Twenty dairymen entered their farms to compete for the prizes and they were visited by the judges and scored on the basis of the score card herewith. While this part of the work required considerable time and some expense, it is believed that it resulted in much good along the line of improving the conditions affecting the city milk supply. Full details of this feature of the work are given in Table 3.

SCORE CARD FOR DAIRY FARMS.

The following is a copy of the score card used:^a

[Front of card.]

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SANITARY INSPECTION OF DAIRIES.

DAIRY SCORE CARD.

Owner or lessee of farm _____.
 Town _____. State _____.
 Total number of cows _____. Number milking _____.
 Quarts of milk produced daily _____. Product is sold at wholesale retail. Name
 and address of dealer to whom shipped _____.
 Permit No. _____. Date of inspection _____, 190____.
 Remarks _____.
 (Signed) _____, *Inspector*.

^a A later and more simple form of card, embodying certain additional educational features, has since been adopted by the Official Dairy Instructors' Association as well as by the Dairy Division, and is shown on pages 35 and 36 of this circular.

[Back of card.]

DETAILED SCORE.

Equipment.	Score.		Methods.	Score.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Condition.....	4	.....	Cleanliness.....	10	.....
Health (outward appearance).....	6	.....	STABLE.		
Comfort.....	4	.....	Cleanliness.....	12	.....
Bedding.....	2	.....	Floor.....	4	.....
Temperature of stable.....	1	.....	Walls.....	2	.....
Protected yard.....	1	.....	Ceiling.....	2	.....
Cubic feet of space per cow:		.....	Ledges.....	1	.....
Over 300, 2; over 400, 4; 500		.....	Mangers and partitions.....	1	.....
to 1,000, 6.....	6	.....	Windows.....	1	.....
Feed.....	4	.....	No other animals in		.....
Water.....	8	.....	stable.....	1	.....
Clean.....	6	.....	Stable air.....	4	.....
Fresh.....	2	.....	Removal of manure.....	4	.....
STABLE.			To field or proper pit.....	4	.....
Location.....	6	.....	30 feet from stable.....	2	.....
Well drained.....	3	.....	Cleanliness of stable yard.....	2	.....
Free from contaminat-		.....	MILK ROOM.		
ing surroundings.....	3	.....	Cleanliness.....	6	.....
Construction.....	10	.....	Care and cleanliness of utensils	10	.....
Tight, sound floor.....	3	.....	Inverted in pure air.....	2	.....
Gutter.....	1	.....	Clean (superficially).....	4	.....
Stall, stanchion, tie.....	1	.....	Sterilized.....	4	.....
Low-down manger.....	1	.....	MILKING.		
Smooth, tight walls.....	1	.....	Cleanliness.....	14	.....
Smooth, tight ceiling.....	2	.....	Clean, dry hands.....	4	.....
Box stall.....	1	.....	Udders washed and		.....
Light: 1 sq. ft. glass per cow, 2;		.....	dried.....	10	.....
2 sq. ft., 4; 3 sq. ft., 6; 4 sq.		.....	Cleaned with		.....
ft., 8; even distribution, 2.....	10	.....	moist cloth.....	8	.....
Ventilation: sliding windows,		.....	Cleaned with		.....
2; hinged at bottom 4; King		.....	dry cloth.....	4	.....
system or muslin curtain 8.....	8	.....	CARE OF MILK.		
Stable yard (drainage).....	2	.....	Cooling.....	20	.....
MILK ROOM.			Removed from stable		.....
Location.....	6	.....	immediately after		.....
Convenience.....	2	.....	milking each cow		.....
Free from contaminat-		.....	and promptly cooled.....	10	.....
ing surroundings.....	4	.....	Cooled to 50° F or be-		.....
Construction.....	4	.....	low.....	10	.....
Floor.....	1.5	.....	51° to 55° F.....	8	.....
Walls and ceilings.....	1	.....	56° to 60° F.....	6	.....
Light.....	.5	.....	Storing.....	8	.....
Ventilation.....	.5	.....	Below 50° F.....	8	.....
Screens.....	.5	.....	51° to 55° F.....	6	.....
Arrangement.....	2	.....	56° to 60° F.....	4	.....
Equipment.....	6	.....	Transportation.....	10	.....
Hot water or steam.....	2	.....	Iced in summer.....	10	.....
Cooler.....	2	.....	Jacket or wet blanket		.....
Narrow-top milk pail.....	1	.....	in summer.....	8	.....
Other utensils.....	1	.....	Dry blanket.....	4	.....
Water supply for utensils.....	10	.....	Covered wagon.....	2	.....
Clean.....	6	.....	Total.....		
Convenient.....	2	.....	100		.....
Abundant.....	2	.....	Total.....		
Milking suits.....	4	.....	100		.....
Total.....			Total.....		
100		.....	100		.....

Score of methods..... multiplied by 2=

Score of equipment..... multiplied by 1=

Total..... divided by 3= final score.

NOTE.—Deductions may be made for exceptionally bad conditions.

NOTE.—If the herd has not been tuberculin tested within a year, the limit for the score will be 80.

DETAILS OF THE SCORING.

Table 3 shows the details of the scoring on each entry in the contest:

TABLE 3.—Detailed scores of the twelve farms entered in the dairy-farm contest.

Farm number.	Equipment.							Methods.								
	Cows (health, comfort, etc.), perfect 20.	Feed and water, perfect 12.	Stable (location, construction), perfect 36.	Milk room, perfect 18.	Water supply, perfect 10.	Milking suits, perfect 4.	Total score, perfect 100.	Cows (cleanliness), perfect 10.	Stable (cleanliness), perfect 16.	Stable yard and removal of manure, perfect 6.	Milk room and utensils (cleanliness), perfect 16.	Milking, perfect 14.	Care of milk, perfect 20.	Storage and transportation, perfect 18.	Total score, perfect 100.	Final score (methods $\times 2$ + equipment, divided by 3), perfect 100.
1.....	19.5	12.0	22.5	15.0	10	0	79.0	7	11.5	6.0	15	10	18	6	73.5	75.33
2.....	18.0	11.0	24.5	14.5	8	3	79.0	9	12.0	5.0	12	12	16	6	72.0	74.33
3.....	19.0	12.0	28.0	13.5	10	0	82.5	9	15.0	6.0	11	4	8	12	65.0	70.80
4.....	17.5	10.5	26.0	17.0	10	0	81.0	7	9.0	5.0	10	8	18	8	65.0	70.33
5.....	19.0	12.0	21.5	10.0	10	2	74.5	9	12.0	5.0	10	8	8	10	62.0	66.00
6.....	19.0	12.0	26.0	14.5	10	0	81.5	9	11.0	0.0	11	8	8	12	59.0	66.50
7.....	19.0	12.0	14.0	9.5	10	0	64.5	6	6.0	3.0	11	14	16	8	64.0	64.00
8.....	19.0	12.0	24.0	9.5	10	0	74.5	9	14.0	1.0	10	4	8	6	52.0	59.50
9.....	17.0	10.0	18.5	12.0	8	0	65.5	7	9.5	1.0	10	8	10	10	55.5	58.83
10.....	13.0	9.5	22.0	8.5	8	0	61.0	8	12.0	5.5	10	10	6	6	57.5	58.66
11.....	14.0	10.0	17.5	10.0	10	0	61.5	7	7.0	5.0	8	6	6	6	45.0	50.50
12.....	19.0	12.0	18.0	8.0	10	0	67.0	9	3.0	2.0	8	4	8	6	40.0	49.00
Average.....	17.8	11.2	21.8	11.8	9.5	0.4	72.5	8	10.2	3.7	10.5	8	10.8	8	59.2	63.6
Average per cent perfect.....	88.8	93.8	60.8	65.7	95.0	10.0	72.5	80	63.8	61.6	65.6	57.1	54.0	44.5	59.2	63.6

PRINCIPAL DEFECTS FOUND.

Among the principal defects found on the dairy farms were unclean stables and lack of light and proper ventilation. There were also some defects found in the construction, equipment, and cleanliness of the milk houses and the handling and cooling of the milk. The feed of the cows and the water supply were generally good. The average score for equipment—72.5 points—is commendable. The average score for methods—59.2 points—indicates a good many defects in cleanliness and in handling the product, and it should be improved. The average score for all conditions was 63.6, a rating considerably above the average of dairies throughout the country.

LIST OF PRIZE WINNERS.

	MILK.	Score.
First prize: A gold medal, awarded to L. M. Zediker.....		95½
Second prize: A silver medal, to Sidney Schiever.....		95½
Honorable mention: The following dairymen whose milk scored 94 points and over:		
F. G. Brown.....		95
F. D. Cresey.....		94½
D. A. McCalamont.....		94
W. K. Briggs.....		94
Louis A. Handt.....		94
J. C. Weaver.....		94

CREAM.

	Score.
First prize: A gold medal, awarded to J. F. Hudson.....	92
Second prize: A silver medal to L. Garbe.....	90

DAIRY-FARM CONTEST.

First prize: A gold medal awarded to Joseph Groves.....	75½
Second prize: A silver medal to F. G. Brown.....	73½
Third prize: A silver medal to George D. Paxton.....	70½
Honorable mention:	
Hartman Brothers.....	70½
Robert Bamford.....	66
J. W. Quivey.....	66½

ADDRESSES AND PAPERS.

The morning session was called to order by C. B. Lane, assistant chief of the Dairy Division.

After congratulating the dairymen of the Pittsburg district upon what he said was the largest dairy contest ever held in this country or any other, Mr. Lane spoke in part as follows:

OPENING REMARKS BY C. B. LANE.

We have come here to consider the most important food, the cheapest food, the food that nourishes four-fifths of the babies of this country, the food that has no substitute—pure milk. The problem of providing clean, healthful milk for the 90,000,000 people of this country is occupying the attention of the physician, the chemist, the bacteriologist, the veterinarian, and the sanitarian as never before.

It is only a few short years since the science of bacteriology has been applied to the milk supply of cities; since, in fact, we have given this subject of milk any really serious thought. The question of sanitation is one that is uppermost in the minds of the people to-day, and no science has made such rapid progress during recent years as this. The entire civilized world is throwing itself into the fight against unnecessary insanitary conditions, against unnecessary sickness, and against unnecessary and shameful loss of life resulting from insanitary conditions, from impure milk, and from all impure food supplies. It is said to-day that national intelligence may be known by national sanitation. General conditions being the same, the city having the best milk has by far the lowest death rate. One city in our own country reduced the death rate of children under 5 years of age, from all causes, from 33 per cent to 15 per cent, the diminution beginning immediately on the improvement of the milk supply. The city of Copenhagen, Denmark, reduced its death rate from one of the highest to the lowest by simply purifying the milk supply. We can hardly exaggerate the full importance of pure milk, and every citizen should feel a proper sense of responsibility in the matter and insist that all reasonable health laws be complied with.

The demand is made that the dairymen of this country improve their methods, adopt new standards, and meet new demands. Some of the sanitary theories may be overdrawn and some unfair demands may sometimes be made upon producers, but there is one thing certain—the dairymen of Pittsburg and of every other city will have to deal with this reform movement, and how this can best be done is one of the subjects that will be discussed here to-day. The demand is also made, and rightly, that the consumer do his part toward bringing about an improvement in the product which he has on his table daily.

If I were to pass judgment on the producer and consumer, I am inclined to think I should give the producer the credit for having advanced farthest in doing his part

in the fight for pure milk. The consumer needs to be educated to take proper care of milk when it reaches his door. Unfortunately, the law stops at the consumer's door, but it follows the producer all the way from the cow to the kitchen. If we should examine conditions to-day, we should find many a filthy ice box that is far worse than the worst examples of dairymen's milk houses. The consumer should examine the source of his supply and pay the dairyman a living price when the product is delivered to him in good condition, rather than be looking for the cheapest milk he can buy. The average consumer is surprisingly ignorant concerning his milk supply. He not only does not realize the importance of having pure milk, but he is ignorant concerning its greater cost. Three-fourths of the milk consumers of this country have never looked up the source of their milk supplies or seen any account of them.

It is interesting to note the strides that the milk producers are making in this world-wide effort to improve the quality of milk. Dairymen in all sections are becoming interested to raise the standard of their business; and National, State, county, and local meetings are being held everywhere to discuss these matters. The fact should not be overlooked that the vital question, financially, is not so much securing a better price as it is cheaper production. To illustrate: In one county in your neighboring State that was investigated it was found that more than half of the farmers were getting less than 3,500 pounds of milk a year from their cows, and more than half received less than a dollar for every dollar they spent in feed. We need to look at things more and more from a business standpoint. Is it to be wondered at that these men receive only beggarly returns from their cows when only one dairyman out of ten reads any paper devoted especially to his life work?

The milk supply of Pittsburg ought to be as nearly perfect as possible. The United States Department of Agriculture is very glad to have this opportunity of sending representatives to this city and of giving you any assistance possible. We want to get closely in touch with your work. We want you to ask questions, and we want to receive information as well as give it. The object of this meeting is educational, looking toward better dairy conditions, better milk, and better prices.

REMARKS BY PRESIDENT SMITH, OF THE CHAMBER OF COMMERCE.

Mr. Lee S. Smith, president of the chamber of commerce, gave the address of welcome and spoke in part as follows:

I want to welcome you on behalf of the chamber of commerce to these rooms. Chambers of commerce were organized some hundreds of years ago for a single purpose or object—to better the condition of the business of those who were connected with them—and for hundreds of years they followed that line almost exclusively. But for years past this chamber of commerce has been seeking to do things that would tend to elevate our citizenship and make our city better worth living in—to enlarge it and to make it a better Pittsburg in reality as well as numerically—and I think we have accomplished a great deal. When this milk contest was brought to our attention, the chamber of commerce took it up unanimously and said it was just one of the things we ought to take hold of. I am glad to say that in the weeks that have passed since we made that determination I have been congratulated by people on the interest we are taking in this great work.

RESPONSE BY JOHN W. QUIVEY FOR MILK PRODUCERS.

Mr. John W. Quivey, of Houston, Washington County, Pa., responding on behalf of the milk producers, said in part:

On behalf of the large number of people engaged in milk production and located in this busy Pittsburg district, I can say we appreciate the efforts of the chamber of

commerce in trying to arrange for more friendly relations between the producer and the consumer of the products of our dairy farms. We think when they see the number who were interested to such an extent as to compete for the prizes they have offered, they will realize far better than I can say to them that we are willing to meet the consumer on neutral ground and have a good time, show him samples of our products, and have these representatives from our experiment stations and the Agricultural Department at Washington tell them in what kind of places we keep our cows and tell us how to remedy some of our shortcomings.

Did you ever stop to think what an immense industry we represent? The last census shows over 16,000,000 milk cows in the United States, worth over \$500,000,000; the value of their products—milk, butter, and cheese—is above \$500,000,000; the total value is, therefore, more than \$1,000,000,000. The farm lands and equipments representing this industry are worth several times this amount. Estimating one man to care for ten cows, the dairy industry requires the services of nearly two millions of our population, in many cases requiring special training and superior skill such as command large salaries in other callings.

The tendency of all business interests the last few years has been toward combination, but of all interests dairying seems to be the least adapted to uniting all branches under one head. The future of our industry seems to be with the small farmer who has from 10 to 20 cows. To such as have a knowledge of the business and are so situated that they can sell direct to the consumer, I think this industry has a bright outlook. But we are not all so located and must depend on the middlemen for a market for our product.

The dairy farmer of the future must make his products so wholesome, the quality and condition so attractive, as to defy competition. The consumption of milk and cream is increasing at a rapid rate in our cities and towns. The demand is practically unlimited, depending only on the ability of the dairyman to furnish a pure, clean, and palatable article. Good quality should mean better prices, but in too many instances a great deal more attention has been given by boards of health to educating the farmer or dairyman as to the necessity for cleaner milk and the methods of producing it than has been given by them to educating the consumer as to the increased money value in such milk. It is right and proper that milk intended for human consumption should be as free as possible from contamination, but to accomplish this increases the cost, and who is going to pay the farmer for his additional outlay? It certainly costs more to produce a clean milk than the other kind, owing to the increased labor, and it is only right that the consumer should be willing to pay more for such milk. It is our privilege and duty to demand such legislation as will protect our just rights, but we, as dairymen, should make every effort that care, science, and skill can make to improve our dairy products and place them on the market in a wholesome and attractive form. Our products have often been carelessly made; fraud and deception have been practiced to such an extent that the consumer has lost confidence. Convince the people of our cities by honest merit in our goods that they are honestly and carefully handled from the cow to the consumer's table, and confidence will be restored and greater things are in store for the dairy industry than were dreamed of.

THE ESSENTIALS FOR THE PRODUCTION OF WHOLESOME MARKET MILK.

By Prof. H. E. VAN NORMAN, *State College, Pa.*

Out of the close contact which the medical profession necessarily has with the life of the human race came some years ago the realization that there is a tremendously high death rate among the city children fed on cow's milk. Investigation has led to the conviction that a large proportion of the deaths among milk-fed infants are due to faults in the milk which develop there after the milk is drawn from the cow.

Some of the trouble is due to bacteria which are the direct cause of disease, but some is also due to those forms which, although not in themselves causing disease, yet

in the course of their growth develop products that may be injurious to the delicate stomach of the weak or sickly infant. The latter class is much the more common. Such bacteria may come from the surface of the udder and flanks of the cow, the dust in the air of the barn at milking time, from the clothing and hands of the milkers, or from the improperly cleaned cans and other vessels. Manure, hay, straw, and other solid matter may be strained out of the milk, but fine wire, cloth, cotton, or filter paper will not strain out the minute bacteria which have been carried into the milk by this foreign material and which can cause so much trouble.

It is the knowledge of these facts which has led to the vigorous and, unfortunately, sometimes unreasonable campaigns started for the justifiable purpose of securing a more wholesome supply of milk for the city babies and invalids.

The milk producer has often failed to realize that because his strong, husky children, born of parents living a vigorous, active, more or less outdoor life, surrounded by plenty of fresh air, have thriven and grown on his milk used within twelve hours of the time it was drawn, it does not prove that it is free from dirt, dust, or bacteria. By the time it had been held from two to twenty hours, hauled or shipped to the city, stood possibly twelve or twenty-four hours in a milk depot, churned over city pavements in a wagon, then dipped from a can in a stuffy grocery into a poorly washed tin or pitcher to stand an hour or more in a warm room, there may have developed in it that which will make the sick baby worse, or even cause death.

Fortunately all milk is not subjected to this treatment after it leaves the farm, neither are all producers careless or neglectful. City health officials are learning that producers are not all bad men, that far the largest number offend from ignorance. The producer is also learning that there may be faults in his product he never dreamed of.

Having heard the extremists' statements on both sides of controversies where none should exist, and knowing something of the situation here in and about Pittsburg, I may congratulate the producer and those charged with the authority and responsibility of protecting the interests of the consumer on the saneness and reasonableness of the attitude and methods used to secure for the people of Pittsburg the best possible milk supply.

The producers are willing to learn, while the authorities realize that changes and improvements cost money. A campaign of education is necessary—education of the consumer to the difference existing in the quality and value of milk; education of the producer to the faults which he may overcome without prohibitory additional expense.

What is essential for the production of a wholesome market milk?

First, there should be thorough appreciation of the fundamental principle of cleanliness and cold.

Cleanliness means to keep dirt out of the milk. Most people would hesitate to set a table in a cow barn and work the cake dough there for five minutes, because of the dust and dirt that would get into it; yet they do not hesitate to handle milk, which is also a food product, not only in the air of the barn but right under the cow where any loose particles can fall in.

By cooling is meant getting the milk cold, not merely going through the motions. To place a can of milk in a vat or spring of water will not of necessity cool it, neither will running it over a cooler do so unless the water in each case is cold enough. What counts is getting the milk cooled to a temperature of 50° F., or, better, 45 degrees, at the earliest possible moment after it is drawn from the cow. The spring water or well water or the city water may be cold enough to do this; if so, well and good; if not, ice may be necessary. The point is, get the milk cold and know that it is cold.

The air of the stable at milking time should be free from dust. Handling hay or grain just before milking has been shown to put twice as many bacteria into the milk drawn immediately afterwards, while the handling of dry corn fodder put three times as many in. Brushing the cow doubled the number of bacteria. Not stripping the

cow thoroughly seemed to increase the number of bacteria in the next milking. Different milkers showed a big variation in the number of bacteria in the milk drawn by them, some men producing milk with only one-third as many bacteria under similar conditions. Boiled water in which the milker washed his hands before milking was shown to contain 45,000,000 bacteria per cubic centimeter. All of these and many more figures might be given to emphasize the importance of this part of the work.

Under ordinary farm conditions I would recommend the use of a small-top milk pail. An opening 6 inches in diameter exposes approximately one-fourth as much surface to collect dirt as does a pail with an opening or top of 12 inches. If the small opening is not quite vertical so that the milk enters the pail from the side, still less dirt will get in. Having taken these precautions to secure clean milk, it should be removed immediately from the barn and not poured from one vessel to another in air laden with odors from the manure and dust from the feed.

Aeration—that is, exposing to the air by running over a cooler—is a good thing if the air is pure; otherwise it is objectionable. If cooling is done by placing the cans in water they should be stirred once or twice during the first hour, as this will very materially increase the rapidity of cooling.

Another factor in this problem to which all concerned should give attention is the practice prevailing in places of not washing milk cans immediately on emptying. Milk is allowed to spoil in them, and when the cans get back to the farm they are in a condition which no vessel intended for milk should ever be allowed to get into. Somebody is responsible for this neglect; the responsibility should be fixed and the evil corrected.

In conclusion I may sum up by saying that the essentials for wholesome milk from the standpoint of the handler are healthy cows, in healthful surroundings, milked by clean men in air free from dust and odors, and immediate chilling of the milk; this makes clean cold milk.

LEGISLATION IN REFERENCE TO THE MILK SUPPLY OF THE CITY OF PITTSBURG.

By Dr. J. C. McNEIL, *Veterinarian and Dairy Inspector for Pittsburg.*

Our present milk laws are very full and adequate, and the bureau of health is well fortified to protect the consumers of milk against any impure, unwholesome, or adulterated milk. Not only do the acts of the assembly of 1901 and 1907 and the city ordinances, which embody all the features of these acts, give us sufficient power to refuse to allow the sale of impure, unwholesome, or adulterated milk, but we have little trouble in securing convictions in cases of violation of these laws. The provisions in force are as follows:

Section 1 provides that any person who offers for sale as pure milk any milk from which the cream or any part thereof has been removed or which has been adulterated or changed in any respect by the addition of water or other substances shall be liable to penalties.

Section 2 provides for the sale of "skimmed milk" and says that such milk must have on the outside of each can the words "skimmed milk" permanently soldered in metallic letters not less than 1 inch in height. In case of the delivery of skimmed milk in glass bottles the words "skimmed milk" shall be blown in the bottles in letters not less than 1 inch in height.

Section 3 provides that skimmed milk shall contain not less than 8 per cent of milk solids exclusive of butterfat.

Section 4 provides that any person who shall sell any impure, unwholesome, or adulterated milk, or shall keep cows for the production of milk in a crowded or unhealthy condition, or feed the same on food that produces impure, diseased, or unwholesome milk, or who shall feed cows on distillery waste commonly called swill, or upon any substance of an unwholesome nature, or who shall not allow his cows free

movement in the open air at pasture, weather permitting, at least four hours each day shall be liable to a penalty.

Section 5 defines rather specifically impure, adulterated, and unwholesome milk. This section of the act declares the addition of water, ice, or any other substance to be an adulteration. Milk that is obtained from animals fed on distillery waste, or upon any substance in a state of decomposition, or upon any substance of an unwholesome nature, or milk that has been exposed to or adulterated by the emanations, discharges, or exhalations from persons or animals having any contagious disease, by which the health or life of any person may be endangered, or milk from tuberculous cows, or cows suffering from any febrile disease, is declared to be unwholesome and impure.

Section 6 provides standards for the percentage of water, butterfat, and specific gravity. The minimum for butterfat is 3 per cent, the maximum for water not more than 88 per cent, and the specific gravity at 60° F. shall be between 1.029 and 1.033. All milk of a lower grade shall be deemed adulterated.

Section 7 relates to the healthfulness of the cows, with special reference to tuberculosis, their condition to be determined by physical examinations and the tuberculin test. This section also provides for an inspection of the premises occupied by the cows as regards their sanitary condition, and gives the superintendent of the bureau of health, his officers and experts, the right at all times to have full and free access to any place where such animals are kept, whether such places be within or beyond the limits of the city, and any person impeding such access shall be guilty of a violation of this act.

Section 8 provides for the licensing of all dealers selling milk in the city. The cost of a license is only \$1. The dealer must, however, have printed with his name on the outside of all wagons used in conveyance of milk his license number in letters not less than 4 inches in height.

Section 9 provides penalties for violation of any provision of the act. The penalty for the first offense shall not be less than \$10 nor more than \$25, with not more than \$50 for the second offense, and for each offense thereafter not less than \$50 nor more than \$100. In default of payment of any fine the person so offending may be committed to jail, workhouse, or other penal institution of the county for a period not exceeding 30 days.

I have referred only to the more important features of the laws concerning milk, from which it can readily be seen that our bureau of health has ample power to deal with both producers and dealers. An act of assembly approved April 15, 1907, regulates the sale of milk, skim milk, and cream, and provides that the liquid or wine measure with 231 cubic inches to the gallon shall be the standard of measurement, although nothing in this act will prevent the sale of skim milk, milk, or cream by weight.

Another act requiring the thorough cleansing of the inside of all vessels and cans used in the shipment of milk and cream on railroads was passed by the last legislature and became a law May 25, 1907. This was very desirable legislation and has been of great assistance to the bureau of health in its efforts to give the people of Pittsburg a cleaner milk supply.

For many years the city of Pittsburg has had a system of milk inspection, but this work was more or less mechanical. Formerly an inspector's principal duties were to collect samples from wagons and stores and bring these samples to the laboratory of the bureau of health, where they were examined for adulteration and the use of preservatives and were tested for butterfat. Such work was and still is very important and essential, but in later years the heads of health bureaus have recognized that to get clean, wholesome milk it is necessary to start with the producer. Five years ago dairy inspection was scarcely known in this country, and it was some of the larger dairy companies that first organized a system of inspection of the dairies that furnished them with milk. They realized the necessity for such inspection in order

to give their customers a high-grade milk. It can readily be seen that an effective system of inspection should commence at the farm and with the cow. It matters not how much care may be taken all along the line from the farmer to the consumer, if the cow is not healthy and the stable hygiene is neglected the consumer will surely get an unwholesome milk.

All large cities are now adopting a system of dairy inspection. New York City has a force of 35 dairy inspectors, but when one realizes that it requires the product of 32,000 dairy farms to furnish the city of New York with its milk supply, that number is not more than adequate. These inspectors are able to visit each dairy farm sending milk into the city twice a year. Within the past six months Pittsburg has established a system of dairy inspection. The work has been started with a force of two men, and good results are already being secured. It is estimated that the number of dairy farms shipping milk into Pittsburg is in the neighborhood of 7,000. It can readily be seen that the force is inadequate, but we hope that our city officials may see the necessity for more of this work and increase the force.

It may be interesting to outline the duties of a dairy inspector and to discuss some of the points which should be considered.

The cow.—Commencing with the cow, the first thing that attracts attention is her outward appearance, her condition of flesh, the condition of her hair, her breathing, the look in her eye. The lungs should be auscultated and the udder and teats very carefully examined. Inquiry should be made as to whether or not she has been tested with tuberculin, and if so, when. The comfort of the cow next calls for attention. The bedding, temperature of the stable, the barnyard, the number of cubic feet of air space per cow, and the character of the feed and water should be carefully looked into. Last and by no means the least important feature in connection with the cow is her cleanliness, as a cow can not furnish clean milk when her udder, flanks, and tail are caked with manure. I always recommend the clipping of long hairs from the cow's udder, flank, and tail. It costs the dairyman little or nothing, makes his work of cleaning the udder much easier, and is of great help in producing a cleaner milk.

The stable.—In approaching the cow stable the first thing that attracts the inspector's attention is its location relative to other buildings, its drainage, and the drainage and cleanliness of the stable yard. The disposal of the manure next receives attention. Is it hauled daily to the field, kept in a proper pit, or allowed to rot the boards on the sides of the barn? Entering the stable, the general construction is considered: Has it a sound, tight floor, a gutter, stanchions, low mangers, smooth, tight ceiling, and smooth, tight walls? What is the number of square feet of glass per cow and the method of ventilation? While you are noting the equipment, the cleanliness or dirtiness of the stable is always before you. Too often through the country we find loose ceilings. By that I mean saplings run through the stable with straw or hay piled on top to make the ceiling. Such places invariably have the ceilings and walls covered with dust and cobwebs, and some of this dust and dirt finds its way into the milk. Most dairymen agree with me that cobwebs are a bad thing in a dairy stable, although I had one man argue that they kept down flies and he would be very sorry to part with his cobwebs. The keeping of horses, pigs, or poultry in the cow stable is also very objectionable.

The milk room.—In examining the milk room we note and give credit for its proper location, construction, equipment, arrangement, water supply, milking suits, general condition of cleanliness, and the care and cleanliness of utensils.

Milking methods.—Too much care can not be taken in this most important work. It costs the producer no more to milk cleanly than to do it otherwise if he once forms the habit. In scoring for milking 14 points are allowed as follows: Clean, dry hands, 4; udders washed and dried, 10; making a perfect score. If cleaned with a moist cloth

8 points are given, and if cleaned with a dry cloth only 4 points are allowed. Wet milking is severely condemned.

Care of milk.—Under this head we give credit for proper cooling, storing, and method of transportation.

It is difficult to get trained men who can properly serve as inspectors, since the personal attitude of the inspector is of so much importance. It is manifestly desirable that none except those who thoroughly understand dairies should be employed. Trained men are hard to find, but it is not hard to find persons who will serve as inspectors for the sake of obtaining the salary.

The relation of the inspector to the farmer should be of a most friendly nature, and it should be the purpose of each to help the other. Any respectable farmer would prefer to furnish good rather than poor milk; still it is almost impossible to furnish good milk if the dairyman has no equipment. If he has no floor in his stable, no windows, and no ventilation he can hardly be expected to furnish clean milk. If the inspector can show him the advantages and cheapness of a concrete floor and gutter he probably will put in one in the near future. The inspector can show him the advantages of light and ventilation, and, while the farmer may not be able to put in the King system of ventilation, there is no one too poor to afford a few muslin windows. The dairyman, when you commence talking muslin windows to him, fears that his cows will be too cold, etc.; but if you have made a favorable impression on him, he will be disposed to give them a trial.

Practically all dairies in Greater Pittsburg with its surrounding boroughs and townships have been scored. These score cards are on file at the bureau of health, and they will be gladly shown to any person who is interested in knowing what sort of a place his dairyman keeps.

DAIRY CONTESTS.

By C. B. LANE, *U. S. Department of Agriculture.*

Friendly competition is a great stimulus whether on the athletic field, on the race track, or in the production and manufacture of dairy products. The competition here to-day is in milk and cream, and those who have entered will learn many lessons by seeing their product alongside that of others. If your product scores high you know that you are practicing right methods; on the other hand, if it scores low the faults are clearly pointed out and you learn how to improve. I have watched these contests over the country with much interest from the first, and I assure you that they have already had a great influence in the production of cleaner and better milk. A brief description of some of the various contests may be of interest.

The movement was started at the National Dairy Show in 1906. This was a national contest open to all producers of milk and was held under the supervision of the United States Dairy Division. The object was entirely educational; we desired to show some of the possibilities in the handling and keeping qualities of milk and cream. The handling of dairy products is usually of greater importance to the health of the people consuming them than is the production. The most indifferent dairy farmer can produce milk and cream, but it requires knowledge and skill to handle them properly. For example, one man in the Chicago contest had 21,000,000 bacteria per cubic centimeter in his milk and his product soured very shortly after reaching Chicago; another shipped his milk 500 miles and no bacteria could be found in it, and this milk kept five weeks before souring. These contests, then, show the dairyman's skill in handling milk. In the first contest the defects were largely off flavor, dirt, and high bacteria. There were 45 samples exhibited, 23 being market milk. The average score for market milk was 89.7 and for cream 93.6. Exhibits were invited from all parts of the country, and dairymen in thirteen different States responded. Some of these samples were shipped over 1,000 miles, yet were found in excellent condition when three days old.

The highest scored up to 98. Some of the milk, as before stated, kept for five weeks, and some of the cream for seven weeks, with no other preservative than cleanliness and cold. Medals were awarded for the best milk and cream, as in the present contest.

The second contest, and I might say the first State contest, was held in New Hampshire, December 6, 1906, in connection with the State Dairy Association. Here 11 samples of milk and 9 samples of cream were exhibited; the average score of the milk was 90.8 and of the cream 91.4. The same defects were found in the milk entered in this contest as in Chicago, namely, some off flavors of silage and dirt, and high bacteria. These defects were carefully pointed out, and the man who had the dirtiest milk last year took the hint and also took a prize in a similar contest this year.

Other contests have been held in Illinois, Pennsylvania, Ohio, Connecticut, Massachusetts, and New York. Cleveland was the first city to hold a contest of this character (1907), and a lively interest was shown. The results were so beneficial to all interested that a second contest was held the present year.

Lessons from milk contests.

Value to the producer.—These contests are helpful to the producer in pointing out to him very clearly the exact conditions of his product and showing him where he can improve. They present an object lesson which is not easily forgotten. They are of value from an educational standpoint; the dairyman comes to understand the importance and significance of improved methods of handling milk, and a contest may be the means of starting him on the road to success. This was certainly true in Cleveland, where, on the inauguration of the inspection work of the board of health, considerable opposition developed among the dairy farmers; but, with a thorough understanding of the object of the inspection which was set forth at the dairy meeting held in connection with the milk contest, this opposition has ceased and inspection is sought and welcomed. The most cordial relations now exist between the dairymen and the inspection department. I am told that the milk contest and the dairy-farm contest held in connection with it definitely contributed to this better spirit.

There is much encouragement for cleaner milk in the future; dairymen are now taking the initiative themselves and are observing the sanitary regulations prescribed by the boards of health. The trouble has been that boards of health have not always met the dairyman halfway in the past; they have gone after him with a club, when they should have first offered suggestions, assistance, and encouragement. Many dairymen do not understand why it is that methods which have been accepted for the past twenty-five years are suddenly condemned. They want an explanation and they are entitled to it. But I believe that when the dairyman understands the importance of greater cleanliness he will be ready to make improvements. Up to the present time there has been but little incentive to the production of high-class milk, with the possible exception of certified milk. Clean and dirty milk have sold for the same price in direct competition with each other. I believe there is going to be a decided change, however, in the near future; the dairyman who produces clean milk will receive a premium for his product, and careful inspection of the dairy farms and the milk produced will bring this about. Already an advanced price is being offered by milk dealers in a number of cities for milk from high-scoring dairies. A score such as those given in this contest, stating certain conditions found in the dairies to be satisfactory, will have a tendency to increase sales and inspire confidence among the consumers.

Value to the dealer.—Milk contests are of value to the dealer in assisting him to determine where the good dairies are, making it easier for him to find a supply of milk to meet the demand made upon him for a good product. With a supply of good milk to handle, there is less trouble with sour milk and less complaint from customers.

Value to the consumer.—The principal value of these contests to the consumer is in pointing out the defects in milk and showing him what good milk really is. With

the average consumer, however, milk is looked upon as a necessity to be bought as cheaply as possible. If he is asked to pay a higher price, he immediately thinks he is being robbed. He gives little thought to the fact that the price of grain has been increasing during the past ten years and that wages for farm labor are not only higher but the labor is more difficult to obtain. The consumer should know that it costs more to produce clean milk and that it means extra labor and extra care, and the dairyman can not be expected to produce it without reasonable profit.

Application of the plan to other cities.

The results obtained in the contests described in the preceding pages indicate that a similar meeting and exhibit would be of value in improving the milk supply of any city. It is simply a means of reaching the producer, the dealer, and the consumer, and educating them on the subject of clean milk. That the plan has worked successfully in Cleveland and Pittsburg there is no question, and it is believed that there are scores of other cities where similar results might be obtained. Such a contest should have the direct support of the board of health or some organization directly interested in improving the milk supply.

(Good and bad dairy conditions were pointed out by the speaker through the use of photographs and charts.)

TUBERCULOSIS IN CATTLE.

By DR. LEONARD PEARSON, *University of Pennsylvania.*

Tuberculosis is not only a most important disease of mankind, but is also very prevalent among domestic animals, particularly among dairy cattle. The question as to the relation of tuberculosis of animals to tuberculosis in man is one that has recently received a vast amount of study and searching analysis. To summarize the present opinion of the most careful students in this field, I might say that there is no question as to the possibility of the transmission of tuberculosis of cattle to mankind. There are, however, differences of opinion as to the amount or extent of such transmission. It is recognized and has been proven by scientists in practically all civilized countries that tuberculosis of children is not infrequently caused by tubercle bacilli of the type that is characteristic of tuberculosis in cattle. The surgical forms of tuberculosis in children and tuberculosis of the glands of the neck and throat and tuberculous diseases of the organs of the abdomen are most frequently caused by bovine tubercle bacilli. The common "consumption" of the lungs is very rarely, if ever, caused by bovine tubercle bacilli. The most important source of tuberculous infection for man is, of course, people affected with consumption. But even though only 1 per cent of the cases of tuberculosis that arise from year to year are caused by bovine tubercle bacilli, the total number of cases so caused would be very large. In New York City 20,000 new cases of tuberculosis are reported each year. One per cent of milk infection would mean 200 cases each year. Ten per cent would mean 2,000 per year. Probably the real percentage is between these limits. Tubercle bacilli from cattle enter the milk not only from the udder, but also from the dirt of the stable as it falls into the milk pail from the surface of the cow.

A cow with tuberculosis of the lungs but with a perfectly sound udder does not furnish infectious milk as it is drawn. But the milk is very likely to become infected during the act of drawing or before the milk leaves the stable. Hence the importance of removing from dairy herds not only such cows as have diseases of the udder, but also all cows with advanced or open tuberculosis.

The compulsory tuberculin test of the dairy herds should not be attempted until adequate provision for carrying it out is made by the State. The expense of getting rid of tuberculosis among cattle is of importance to the public at large, and should be shared by the public. To permit it to fall too heavily on the dairymen would ruin

a considerable percentage of milk producers and would greatly increase the cost of milk to consumers. Farmers are suffering from tuberculosis among their cattle to a very large extent through no fault of their own. The knowledge through which protection might come has not until recently been available. The dairy herds have gotten into their present condition gradually, and in most cases without the knowledge of their owners. The State live-stock sanitary board should have an appropriation sufficient to enable it to take up this subject of freeing dairy herds from tuberculosis in a very much more vigorous way than is now possible. The work should begin by the inspection, without tuberculin, of milk-producing herds. All cattle with tuberculosis of the udder or with other visible forms of tuberculosis should be removed from these herds. Where there is reason to believe that a herd is heavily infected, it should be tested with tuberculin, and the tuberculin test should be used where it is the desire of the farmer to clean his herd entirely from tuberculosis and keep it so. The State should cooperate and assist all farmers who have this desire.

The health department of the city of Pittsburgh is to be congratulated upon the inauguration of a system of dairy inspection that is better in plan and character than can be found in any other place in Pennsylvania. The improvement that will no doubt come from the systematic work that is being done by Doctor Edwards and Doctor McNeil will be of great benefit to the milk consumers of this city.

THE SCORING OF MILK AND CREAM.

By IVAN C. WELD, *U. S. Department of Agriculture.*

The judging or scoring of milk or cream is a study of those products not only from a chemical and bacteriological standpoint, but also from the standpoints of flavor and freedom from foreign matter. Certain definite mathematical values are given flavor, composition, bacteria, acidity, and appearance of package and contents. The sample of milk is examined for each of the foregoing conditions and rated according to its merits; and such ratings, when added, constitute the score of the milk sample under consideration, 100 points constituting a perfect score.

Flavor.—In the scheme of scoring, the weight given to this factor is 40 out of 100 points.

The palatability of any food is said to have much to do with its usefulness in nourishing the body. This may be due in part to the increased flow of saliva, which is stimulated by a particularly palatable food. The flavor and odor of milk, it may be said, are those peculiar properties which, acting on the organs of taste and smell, create in the mind of individuals a degree of satisfaction or disgust, as the case may be. In a way, it may be said that the cleaner milk has the better flavor. This brings us to a consideration of the conditions commonly affecting the flavor of milk and cream, namely: (1) Changes in flavor due to the physical condition of one or more cows in the herd; (2) changes in flavor due to one or more cows in the herd eating strongly flavored food; (3) changes in flavor due to the absorption of various odors in the atmosphere where milking is done or milk is stored; (4) changes in flavor due to bacterial infection and the development of bacteria in the milk.

While there is sometimes a combination of defective flavors, any one of which it is impossible to recognize, an experienced person will yet be able to judge the general quality of flavors and odors. In many cases distinct flavors and odors, if present, can be definitely recognized by specially trained men.

Composition.—(Weight, 25 out of 100 points.) About 47 quarts of cow's milk will weigh 100 pounds. Of this about 87 pounds is water, 4.95 pounds sugar, 4 pounds fat, 2.6 pounds casein, 0.7 pound albumin, and 0.75 pound ash. These are average figures, and if the composition of a cow's milk was never subject to variations from natural causes one of the somewhat troublesome questions of the past, present, and future milk supply would have been entirely eliminated. But the natural composi-

tion of milk is variable. The percentage of milk solids and water varies not only among different species of mammalia but also among different breeds of cattle and among different cows of the same breed. Some wide variations in composition may also be found in the milk produced by the same cow at different periods.

In view of the constantly changing percentages of milk solids, and also in view of the fact that milk is readily adulterated without materially changing its appearance, and furthermore in view of the fact that consumers can not judge for themselves regarding its quality, it long ago became necessary for the several States and cities to establish certain arbitrary standards for fats and solids in milk, and below which it should not be sold. These standards vary in different States; for instance, in some States a standard of 11.5 per cent total solids is the minimum, while in others 13 per cent is required. In some States a double standard is maintained which allows a lower percentage of milk solids in summer than during the winter months.

While in a few isolated cases the standards seem to be rather high, and therefore subject to well-deserved criticism, in other places they are so low as to admit of skillful adulteration of normal milk, which even then can meet every requirement of the local low standard. From the abundant evidence available I believe the consumer of milk can reasonably demand a milk that will contain not less than 3.25 per cent fat, or 8.5 per cent solids not fat, and a milk in which these combined shall equal at least 12 per cent.

To be sure, individual cows have been bred to produce an enormous flow of milk that will not normally contain so much as 12 per cent solids. These same selected cows may also be so bred that their progeny will in turn give even a greater amount of still thinner milk. It thus becomes possible by following a certain line of breeding to accomplish in that way precisely what has sometimes been accomplished by using the pump. Either practice, however, leads to the same result, and an arbitrary standard for fats and for solids not fat in market milk has long been, and doubtless will continue to be, the surest safeguard not only to the consumer of milk but for the honest producer and distributor as well.

The percentage of fat in milk and cream is determined by the well-known Babcock method. Knowing the percentage of fat, the solids not fat may be most conveniently estimated by (1) determining the specific gravity of the milk, or (2) the use of a short rule, namely, add two-tenths of the per cent of fat to one-fourth of the lactometer reading.

Bacteria.—(Weight, 20 out of 100 points.) While certain forms of bacteria may be useful in the manufacture of butter and cheese, we may safely conclude that so far as market milk and cream are concerned the fewer germs of any kind contained in these products the better for all concerned.

While milk in the udder of a healthy cow may contain bacteria, practically all contamination takes place after the milk leaves the cow's udder. The extent of the contamination depends almost entirely upon the conditions under which the milk is drawn and handled. Clean milk can only be secured by clean milkers who use clean utensils and who do their work under clean cows and in a clean atmosphere. There are various ways by which cleanliness may be secured. The expense of cleanliness need not be great, but the absence of it may be and sometimes is most damaging to a dairyman as well as to a community.

Basing my opinion upon the work of many clean and successful dairymen, I believe that certified milk in order to be scored perfect should not contain over 1,000 bacteria per cubic centimeter, and that a perfect market milk should not contain over 10,000 bacteria per cubic centimeter. Milk and cream containing bacteria in excess of the above-mentioned standards are scored according to the conditions found (see score card for milk), but no certified milk containing over 40,000 bacteria, and no market milk containing over 500,000 bacteria per cubic centimeter should be entitled to a single point on the score card.

The number of bacteria in milk or cream may be determined in the following manner: The bottle of milk is vigorously shaken so a fair sample can be secured. A 1 c. c. pipette (sterilized) is filled and the sample is transferred to a flask containing 99 c. c. of sterilized water, thus diluting the milk 100 times. A definite amount of milk thus diluted is then transferred to a sterilized Petri dish. To the diluted milk is added a culture medium (2 per cent lactose agar) melted or in a liquid condition. The diluted milk and culture medium are well mixed. The culture medium solidifies as its temperature lowers, and each individual germ is made stationary in the solidified jelly. The dishes and contents (milk and culture medium) are then placed in an incubating oven at about 95° to 98° F., where for two days the germs are allowed to grow. At the end of that time each original germ will have multiplied a sufficient number of times to form a colony large enough to be seen with the naked eye. By the aid of specially devised apparatus the colonies are counted. The necessary calculations are made, according to the dilution of the milk sample, and the total number of germs originally in the milk is known.

Acidity.—(Weight, 5 out of 100 points.) It seems to be a well-established fact among authorities that acids other than lactic acid are present in newly drawn milk. Any increase in the total amount of acid over that originally present in milk is due to the formation of lactic acid. According to the best authorities the formation of lactic acid in milk is the result of the presence and activity of bacteria. It has been demonstrated that when the total acid amounts to as much as 0.2 per cent the lactic-acid producing bacteria have usually become thoroughly established in the milk, and under fairly favorable conditions will soon render the milk sour and unmarketable. We can, therefore, understand the desirability of knowing definitely the amount or degree of acidity in the samples submitted in competition. The acidity of milk or cream is usually determined by titration. A given quantity of milk or cream—say 50 c. c.—is treated with a few drops of phenolphthalein, a chemical which in an acid solution is colorless like water but which in an alkaline solution is red. To the 50 c. c. of milk containing this chemical is added a sufficient amount of one-tenth normal alkali to neutralize the acid, when the milk or cream will be changed to a light pink color. The amount of alkali required to do this is carefully noted. As one cubic centimeter of one-tenth normal alkali will neutralize 0.009 gram of acid, the percentage of acid is determined by multiplying the number of cubic centimeters of alkali required by 0.009, dividing the result by 50 (or the number of cubic centimeters of milk or cream used), and then multiplying the product by 100.

Appearance of package and contents.—(Weight, 10 out of 100 points.) Since the practice of dipping milk from open cans on the street is highly objectionable, and the drawing of milk through a faucet from cans in the delivery wagon is an equally bad practice, it is found desirable to make use of some small package well adapted to delivering milk to the retail trade. During the past few years several new packages have appeared on the market and attracted more or less attention. Some have been constructed entirely of paper and some of paper and tin. In many cases packages of this class are very useful for grocery and market men who retail molasses, vinegar, kerosene, oysters, etc. In a limited way they are also well adapted for distributing hot coffee or milk to city laborers who are dependent on lunch rooms and restaurants for food supplies. In a small way such packages are also useful in retailing milk over the counter of the city milk plant, but experience has taught dairymen who have tried to use such packages in their regular retail wagon business that they are usually unsatisfactory in several important respects. As yet we have found no package that for attractiveness and general desirability can compare with the glass bottle. A retail package for milk should be free from metal or rubber parts. It should be so constructed as to enable rapid and thorough cleaning. The sterilizing of bottles used in the retail trade is particularly desirable and is not difficult to accomplish. Clean new milk should not be put in bottles that are in any way unattractive or unclean. We

must at first please the consumer's eye by showing him a clean, attractive package, entirely free from sediment or foreign matter. The milk must be well protected by a tight-fitting bottle cap. If a little boiling hot paraffin is poured on the top of the cap after it is in place it enters into every little crack and opening and effectually seals the bottle, making it practically air-tight. The paraffin also protects the cap, and the milk as well, from the hands of the dairyman, and from the dust, rain, or mud. Another thing that helps to protect the cap and also the milk is a parchment-paper covering for the top of the bottle. A paper covering is less expensive than metal and answers practically every purpose. Such a covering may be used either with or without the paraffin above mentioned. It affords additional protection to the milk and is especially desirable when bottles of milk are to be packed in crushed ice for shipment or for delivery.

It will be observed that a milk and cream contest systematizes and makes possible a study, in detail, of the various influences affecting the milk and cream supply. Such an exhibition brings to both producers and consumers of milk knowledge of an extremely practical value. It also promotes a desire on the part of the producer to supply only milk and cream of superior quality. Finally, it helps to teach the consumer that some milk is vastly superior, as a food, to other milk, and that a corresponding difference in price is after all but entirely natural and reasonable.

PROFITS OF A DAIRY FARM.

By Prof. OSCAR ERF, *Ohio State University, Columbus.*

Dairying in American agriculture is fast becoming a necessity because of its usefulness in sustaining and restoring the fertility of the soil. Many facts on record prove that soils devoted to dairying may be as fertile after centuries of farming as they were in the original state. In the densely populated countries of Europe dairying is the chief branch of agriculture because it has been found by actual experience that this branch of farming will furnish the greatest amount of nutrients to supply humanity for the least amount of loss. Lands that were abandoned in European countries centuries ago have been made fertile again by dairy farming. We have illustrations in America, even at the present time, where farms in the Atlantic States which had been abandoned because of unproductiveness, have been taken up again recently, and with good dairy farming made as productive as they were in their original state.

In grain farming the fertility of the soil is removed by selling the grain. We find that approximately \$8.35 worth of fertility is removed from the soil with the sale of every ton of wheat, while with every ton of corn that is sold approximately \$6.50 worth of fertility is lost to the soil; but in the case of dairying, where butter is made, and where all the by-products are fed to the pigs and calves, we find that only 36 cents' worth of fertility is removed for each ton of butter produced. The commercial value of a ton of wheat at 75 cents a bushel is approximately \$24.75. The commercial value of a ton of butter at 25 cents a pound is \$500. For each \$100 worth of wheat that is sold from the soil \$34.50 worth of fertility is removed from the farm, but for every \$100 worth of butter that is sold only 7 cents' worth of fertility is removed from the soil.

This vast difference between wheat farming and dairy farming is explained in this way: Suppose a cow is fed a ration of alfalfa hay and corn, both of which have been raised on the farm. The cow assimilates approximately 10 per cent of the fertilizing elements, the remaining 90 per cent going back to the farm in the shape of manure. Of the 10 per cent of fertilizing elements that are removed by the cow, about three-fourths go to make milk and one-fourth goes to the maintenance of the body. In the case where butter is made on the farm and milk is separated, its analysis shows that 90 per cent of the fertilizing elements of the whole milk is found in the skim milk; hence, cream and butter remove about 10 per cent of the whole amount. The skim milk is returned to the farmer and fed to the pigs and calves. These utilize part of

the material for building up the body and the unassimilated part passes on to fertilize the soil.

It behooves the American dairyman to practice a line of farming which is intensive and by which he can keep up the fertility of the soil.

The ordinary market milk, such as we find on the average farm, and which comes from herds that are not inspected nor tested for tuberculosis, is the milk that should be delivered to the consumer for the smallest possible price so as not to discourage consumption, but at the same time there should be a profit for the producer and for the distributor.

The public has criticised the dairyman for raising the price of milk, and various assertions have been made through the press that milk producers have formed a combine which is responsible for the advanced price. This, however, is entirely unfounded, and when an examination is made of the real situation the consuming public will find that, owing to the enormous rise in the price of feed and the expense of building in order to provide more sanitary conditions, together with the extra demands that the board of health has put upon the dairyman, dairy farming has become much less profitable, so much so that many of the farmers have gone out of business, while those who have remained have been obliged to raise the price of their products. With this in view it is my intention to itemize the cost of keeping a cow for a year, the following being a conservative estimate of the cost of feed required for this period:

Cost of one day's ration—	
8 pounds bran, at \$26 per ton.....	\$0. 104
1 pound cotton-seed meal, at \$29 per ton	.0145
4 pounds corn, at \$1 per cwt.....	.04
30 pounds silage, at \$2.25 per ton.....	.0337
5 pounds corn stover, at \$3 per ton.....	.0075
5 pounds clover hay, at \$10 per ton.....	.025
Total.....	.225
The above rations for 215 days.....	48.48
Pasture for 5 months, at \$1.75.....	8.75
One pound of cotton-seed meal daily for 5 months.....	2.17
Total cost for the year.....	59.40

Many cows, however, take more feed than is prescribed in this ration, and can well digest more. As an illustration, Rosa Bonheur Fifth, of considerable fame in the Holstein breed, gave the enormous yield of 2,989 pounds of milk in thirty days, but her maximum daily ration at the height of the period was 114 pounds of ensilage, 12 pounds of corn meal, 9 pounds of oats, 3 pounds of bran, 9 pounds of oil meal, and 27 pounds of roots. Hence it may be seen that the ration prescribed above is economical in every sense of the word.

The total items of cost, including feed, in keeping a cow are estimated as follows:

Feed cost.....	\$59.40
Labor for one man.....	24.00
Interest, at 6 per cent on cost of cow (\$50).....	3.00
Allowance for deterioration by age.....	2.50
Allowance for death by disease or accident.....	1.50
Allowance for failure to breed.....	.25
Allowance for interest on cow barn.....	3.00
Bull service.....	2.00
General maintenance expense.....	2.50
Hauling.....	2.16
Straw for bedding cow.....	2.00
Total expense.....	102.31

We are often asked the question, How is it that dairymen have not discovered the enormous loss compared with the former cost of keep, and have still kept on producing milk and other dairy products? This can usually be explained from the table below, which shows the average cost of keeping a cow ten years ago:

Feed cost.....	\$22. 50
Labor for one man.....	9. 50
Interest on cost of cow (\$30).....	1. 80
Allowance for deterioration by age.....	1. 70
Allowance for death by disease or accident.....	1. 20
Allowance for failure to breed.....	. 25
Allowance for interest on cow barn.....	1. 50
Bull service.....	2. 00
General maintenance expense.....	1. 50
Hauling.....	1. 20

Total expense..... 43. 15

From this table it will be seen that the cost of keeping a cow has more than doubled in ten years.

The following table shows the cost per gallon of producing milk from cows of various capacities at the present-day maintenance price of \$102 a year, after making an allowance for value of manure and calf:

If cow gives 3,000 pounds of milk yearly, milk will cost per gallon.....	\$0. 292
If cow gives 4,000 pounds of milk yearly, milk will cost per gallon.....	. 22
If cow gives 5,000 pounds of milk yearly, milk will cost per gallon.....	. 176
If cow gives 6,000 pounds of milk yearly, milk will cost per gallon.....	. 146
If cow gives 7,000 pounds of milk yearly, milk will cost per gallon.....	. 125

Ten years ago these cows produced the same amount of milk at a cost of \$43 a year, which would make the cost per gallon as follows:

If cow gave 3,000 pounds of milk yearly, milk would cost per gallon.....	\$0. 124
If cow gave 4,000 pounds of milk yearly, milk would cost per gallon.....	. 093
If cow gave 5,000 pounds of milk yearly, milk would cost per gallon.....	. 074
If cow gave 6,000 pounds of milk yearly, milk would cost per gallon.....	. 062
If cow gave 7,000 pounds of milk yearly, milk would cost per gallon.....	. 053

In the production of butterfat the problem corresponds with that of milk production; hence with a maintenance cost at \$102 a year at the present time and \$43 ten years ago the results would be as follows:

Cost of producing butterfat now and ten years ago, with cows yielding from 200 to 450 pounds per annum.

	Cost per pound.	
	At present.	Ten years ago.
	Cents.	Cents.
With cow producing annually 200 pounds of butterfat.....	51. 0	21. 5
With cow producing annually 250 pounds of butterfat.....	40. 9	17. 3
With cow producing annually 300 pounds of butterfat.....	34. 0	14. 4
With cow producing annually 350 pounds of butterfat.....	29. 2	12. 4
With cow producing annually 400 pounds of butterfat.....	25. 6	10. 4
With cow producing annually 450 pounds of butterfat.....	22. 8	9. 6

It behooves the dairyman, therefore, to keep fewer cows and to pay more attention to the kind of cows he is keeping, as it is clear from the above tables that a cow producing a small quantity of milk does not pay for her keep, while one producing from 6,000 to 7,000 pounds or more is profitable.

Much may be said with reference to the recent action of some of the boards of health. While we realize that inspectors have not always been competent, nevertheless we are convinced that there has been an improvement in general milk supply within recent years. The fact must be taken into consideration by the consumer that milk is going to cost him more money than it has in the past. There is no need to argue against this proposition. The attitude of the general consuming public toward the milk question is evidenced by the newspaper and magazine articles that are constantly appearing and by the increased demand for and use of high-priced certified milk.

The regulations which are being put into effect by the boards of health of our cities are evidence that clean milk is demanded. On the other hand, the increased cost of labor and feed and the increased cost of equipment are evidences that the producer must receive more for his product. The law of supply and demand, other things being equal, will take care of the item relating to price which the consumer pays. It therefore becomes necessary to see that the increase in price is brought about effectively as soon as the demands are brought upon the dairyman.

The greatest need that is confronting the public to-day with reference to the milk question is education both on the part of the consumer and of the producer. Men who are more conversant with the dairy business as a business should be appointed on our boards of health. A better corps of inspectors is necessary, men who are not politicians but who are strictly practical, thoroughly familiar with the dairy business, and who are capable of giving instructions instead of being prosecutors. Last and most essential of all, the State needs to provide liberally for a corps of extension workers in dairying to help the farmers when in need.

THE RELATION OF THE HEALTH BUREAU TO THE DAIRYMAN.

By J. F. EDWARDS, M. D., *Superintendent Bureau of Health, Pittsburg, Pa.*

The essential function of the health officer is to safeguard the health of the community which he serves. In the problem of milk supply his duty is to secure for the people the best possible. To accomplish this he must necessarily use all practical measures at his command to get the producer to supply good milk. It is not enough, however, to set up arbitrarily a standard to which milk must conform and expect the producer to do the rest. The enforcement of any law is made easier when people are made to understand the purpose for which that law was made. The milk producer, whether he be farmer or dairyman, will more readily comply with the rules and regulations of the health authorities and meet the requirements of the inspector if he understands what purpose is served by such regulations or requirements.

The farmer who has never heard of bacteria or who does not know that disease may be caused by dirty milk will not carry out the suggestions of the inspector as intelligently as one who knows that the inspector has a very definite purpose in making such recommendations. An incident which occurred during my inspection of a dairy many miles distant from the city may make this point clearer: After the inspection of the dairy, which was a very dirty one, had been completed, the dairyman said his family had used milk all their lives produced in the way he was producing it and none of them had ever been sick. To emphasize his statement he pointed to his year-old baby, certainly the very picture of good health, who had been brought up on the bottle, and asked why his milk was not good enough for Pittsburg babies. When it was explained to him that his baby got the milk fresh and but a few hours old, before the germs which had found their way into the milk along with the dirt of his stable and because of his faulty methods had time to develop in excessive numbers, and that the milk which he shipped to Pittsburg was not fed to Pittsburg babies before it was one to three days older, and that every germ had multiplied a hundred or

perhaps a thousand fold, he saw the question in a new light and recognized that the inspector had a practical purpose in every requirement made.

The first step to be taken toward a proper relationship between the health authorities and the producer is the recognition of the fact that the health officer has a very definite purpose for every rule and regulation laid down for the producer to follow; that this purpose is the protection of the lives and health of the babies under his care as a guardian of the public health.

In Pittsburg last year more than 5,000 babies under 1 year old depended for their subsistence on the milk from your farms. Their health, their very lives, depended largely on the care with which this milk was handled on the farm, during transportation to the city, in the hands of the city distributor, and, lastly, by the consumer himself.

In this city last year 612 babies under 1 year of age died of diarrheal diseases. These deaths were very largely due to bad milk. Pittsburg's water supply, bad as it was last year, caused fewer deaths than its milk supply; scarlet fever, diphtheria, and all other children's diseases combined were not responsible for as many deaths as was its milk supply. These facts differ only in degree from those applying to many other cities. They show why cities are working for an improved milk supply. They show why Pittsburg is vitally interested in securing your cooperation in improving her supply. Your cooperation is necessary, for success depends upon cooperation, and cooperation always rests upon a proper understanding of the end to be gained and the ways and means employed to attain that end.

Milk is the most nearly perfect of all foods, as it contains in an easily digestible form all the nutritive elements required by the body. It is, however, an unstable compound. Nature intended it to be supplied directly by the mother to her offspring. Under such conditions it is perfectly adapted for its intended purpose, but in order to be used as a food for man it must be handled and kept until used, and it is during the handling and storage that damage occurs. Because of its easily assimilable nutrient it forms a favorable medium for the growth of minute plants or germs known as bacteria, and it is from these that the great danger arises. The germs gain access during the milking process, and in the subsequent handling and at ordinary temperatures they multiply with great rapidity. These bacteria are, under ordinary conditions, productive of harm chiefly when they are present in excessive numbers in milk used for infant feeding. In exceptional cases milk may contain the specific germs of infectious diseases.

An excessive number of bacteria in milk is the chief cause of high infant mortality, while the specific germs, when present, are the cause of infectious diseases, and in many instances have caused severe epidemics of typhoid fever, scarlet fever, and diphtheria.

It is because of the potential danger in milk that it must be safeguarded by strict supervision and impartial enforcement of laws. Sanitarians everywhere and the public generally are awakening to the necessity for the adoption of measures for the proper protection of the people from impure, unclean milk, and especially for the prevention of the enormous waste of human life occurring during the first year of life.

The supervision of the milk supply presents greater difficulties than that of any other food. No other food in general use deteriorates so rapidly. In other foods the responsibility for spoiling can be brought home to the seller within a few hours after sale, while the householder who buys milk can not tell whether it is safe or not by its appearance alone. About the only qualities of which he is able to judge are whether it is of sufficient richness and sweetness. The far more dangerous quality, that of contamination by germs, can not be detected except by laboratory methods involving considerable time, and completed long after the milk from which the sample was taken has been consumed. The necessary steps to protect the public must therefore be

taken before the milk reaches them, and must begin at the source of supply on the farms and follow the product until it reaches the consumer.

Pittsburg consumes between 45,000 and 50,000 gallons of milk daily. More than three-fourths of this amount is shipped in by rail from points more or less distant from the city. Northeastern Ohio supplies the largest part, and of sections nearer the city, Washington county supplies most. The milk shipped by rail is received mostly by the larger dealers, who either retail it directly to consumers or act as wholesalers and supply the smaller retailers. Of the latter there are about 2,000 in the city, mostly grocerymen. About 10,000 gallons are supplied by dairymen in and adjacent to the city, who sell it directly from wagons to the consumers.

It can be realized that the problem of inspection of the milk supply of the city is an exceedingly complex one, and to be thoroughly done requires a large force of inspectors, as it involves the inspection of 5,000 farms and dairies, the places of 2,000 dealers, wholesale and retail, together with the points of distribution at the creameries or collecting stations along the lines of the railroads and at the city receiving stations. The work of inspection properly begins at the farm, for, if improper methods are carried out in the beginning, no subsequent treatment can repair the damage.

During the present year the city has appointed two dairy inspectors whose special duties are to visit the dairies and farms for purposes of instruction and cooperation. These men have been selected with special reference to their fitness for the work. One is a veterinarian of exceptional training and experience, the other is a practical dairyman of twelve years' experience. Since they began their work a few months ago more than 500 dairies have been inspected and in the majority of cases improvement has followed. Each dairy visited is rated on a score card on which is noted the essential points in the production of good milk. The policy has been to point out defects in equipment and methods, but except in bad cases to insist at first only on the correction of easily remediable conditions. At practically every place visited the inspector has been cordially received and the dairyman has shown a spirit of appreciation and cooperation.

Practicability, not theory, must be the basis for improved methods. The dairyman is not in the business for sentiment; the law of supply and demand, of profit and loss, governs him as in other lines of business. But here also, as in other lines of business, improved methods and equipment are more profitable than slipshod, slovenly methods and poor equipment, and upon this fact must be based our hope for the future.

LIST OF EXHIBITIONS.

On the following page is a tabular statement showing the most important facts relating to all the competitive exhibitions held in cooperation with the Dairy Division.

TABLE 4.—List of milk, cream, and dairy-farm contests held in cooperation with the Dairy Division.

Name and place.	Date.	Product.	Number of entries.	Average score.
National Dairy Show, Chicago, Ill.....	Feb. 15, 1906..	Market milk.....	23	89.7
		Market cream.....	14	93.6
		Certified milk.....	8	94.8
Granite State Dairymen's Association, Peterboro, N. H.....	Dec. 6-7, 1906..	Market milk.....	11	90.8
		Market cream.....	9	91.4
		Market milk.....	53	90.3
City milk contest, Cleveland, Ohio.....	Mar. 16, 1907..	Market cream.....	6	88.5
		Dairy farms.....	25	64.1
Granite State Dairymen's Association, Whitefield, N. H.....	Dec. 5-6, 1907..	Market milk.....	4	83.2
		Market cream.....	6	89.4
State Dairymen's Association, Marengo, Ill.....	Jan. 13-15, 1908..	Market milk.....	6	93.2
		Market cream.....	2	93.5
Pennsylvania State Dairy Union, Wilkes-Barre, Pa.....	Jan. 14-16, 1908..	Market milk.....	10	91.9
		Certified milk.....	4	95.8
State Dairymen's Association, Columbus, Ohio....	Feb. 12-14, 1908..	Market milk.....	10	89.9
		Market cream.....	12	90.0
State Dairymen's Association, Battle Creek, Mich.....	Feb. 19-21, 1908..	Market milk.....	5	95.5
		Market cream.....	4	94.4
City milk contest, Cleveland, Ohio.....	Mar. 7, 1908....	Market milk.....	38	88.5
		Market cream.....	6	90.5
State Dairymen's Association, Traverse City, Mich.....	Mar. 11, 1908....	Market milk.....	10	91.1
		Market milk.....	50	85.2
City milk contest, Pittsburg, Pa.....	Oct. 22, 1908....	Market cream.....	8	77.7
		Dairy farms.....	12	63.6
		Market milk.....	30	85.7
National Dairy Show, Chicago, Ill.....	Dec. 2-10, 1908..	Market cream.....	20	83.8
		Certified milk.....	14	90.2
		Certified cream.....	6	85.9
State Dairymen's Association, Dexter, Me.....	Dec. 8-10, 1908..	Market milk.....	39	91.6
		Market cream.....	31	88.6
State Dairymen's Association, Burlington, Vt....	Jan. 6, 1909....	Market milk.....	29	90.6
		Market cream.....	16	81.3
Granite State Dairymen's Association, Contoocook, N. H.....	Jan. 13-14, 1909..	Market milk.....	5	92.5
		Market cream.....	7	90.4
City milk contest, Columbus, Ohio.....	Feb. 5, 1909....	Market milk.....	15	91.8
		Market cream.....	7	92.3
State Dairymen's Association, Grand Rapids, Mich.....	Feb. 17-19, 1909..	Market milk.....	6	81.1
		Market cream.....	4	95.2
City milk contest, Toledo, Ohio.....	Feb. 27, 1909....	Market milk.....	7	90.8
		Market cream.....	5	86.0
Kentucky Dairy Cattle Club, Lexington, Ky....	Mar. 13, 1909....	Market milk.....	4	94.2
Michigan Dairymen's and Grand Traverse Dairymen's Associations, Traverse City, Mich.....	Mar. 25, 1909....	Market milk.....	6	93.5

REVISED SCORE CARD FOR DAIRY FARMS.

The following is the latest and simplest form of score card used by the Dairy Division in the rating of farm dairies:

[Front of card.]

[United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.]

SANITARY INSPECTION OF DAIRIES.

DAIRY SCORE CARD.

[Adopted by the Official Dairy Instructors' Association. Subject to revision at future meetings.]

Owner or lessee of farm ____.
 P. O. address ____ State ____.
 Total number of cows ____ Number milking ____.
 Gallons of milk produced daily ____.
 Product is retailed by producer in ____.
 Sold at wholesale to ____.
 For milk supply of ____.
 Permit No. ____ Date of inspection ____, 19__.
 Remarks ____.

(Signed) _____, Inspector.

[Back of card.]

DETAILED SCORE.

Equipment.	Score.		Methods.	Score.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Health.....	6	.....	Cleanliness of cows.....	8	.....
Apparently in good health. 1			STABLES.		
If tested with tuberculin			Cleanliness of stables.....	6	.....
once a year and no tuber-			Floor..... 2		
culosis is found, or if			Walls..... 1		
tested once in six months			Ceiling and ledges..... 1		
and all reacting animals			Mangers and partitions... 1		
removed..... 5			Windows..... 1		
(If tested only once a year			Stable air at milking time... 6		
and reacting animals found			Barnyard clean and well		
and removed, 2.)			drained..... 2		
Comfort.....	2	.....	Removal of manure daily to		
Bedding..... 1			field or proper pit..... 2		
Temperature of stable... 1			(To 50 feet from stable, 1.)		
Food (clean and wholesome)... 2			MILK ROOM.		
Water..... 2			Cleanliness of milk room.....	3	.....
Clean and fresh..... 1			UTENSILS AND MILKING.		
Convenient and abundant 1			Care and cleanliness of uten-		
STABLES.			sils..... 8		
Location of stable.....	2	.....	Thoroughly washed and		
Well drained..... 1			sterilized in live steam for		
Free from contaminating			30 minutes..... 5		
surroundings..... 1			(Thoroughly washed and		
Construction of stable.....	4	.....	placed over steam jet, 4; thor-		
Tight, sound floor and			oughly washed and scalded		
proper gutter..... 2			with boiling water, 3; thor-		
Smooth, tight walls and			oughly washed, not scalded,		
ceiling..... 1			2.)		
Proper stall, tie, and man-			Inverted in pure air..... 3		
ger..... 1			Cleanliness of milking.....	9	.....
Light: Four sq. ft. of glass per			Clean, dry hands..... 3		
cow..... 4			Udders washed and dried. 6		
(Three sq. ft., 3; 2 sq. ft., 2;			(Udders cleaned with moist		
1 sq. ft., 1. Deduct for uneven			cloth, 4; cleaned with dry		
distribution.)			cloth at least 15 minutes be-		
Ventilation: Automatic sys-			fore milking, 1.)		
tem..... 3			HANDLING THE MILK.		
(Adjustable windows, 1.)			Cleanliness of attendants.....	1	.....
Cubic feet of space for cow: 500			Milk removed immediately		
to 1,000 feet..... 3			from stable..... 2		
(Less than 500 feet, 2; less			Prompt cooling (cooled im-		
than 400 feet, 1; less than 300			mediately after milking		
feet, 0; over 1,000 feet, 0.)			each cow)..... 2		
UTENSILS.			Efficient cooling: below 50° F.		
Construction and condition of			(51° to 55°, 4; 56° to 60°, 2.)		
utensils..... 1			Storage: below 50° F..... 3		
Water for cleaning..... 1			(51° to 55°, 2; 56° to 60°, 1.)		
(Clean, convenient, and			Transportation: load in sum-		
abundant.)			mer..... 3		
Small-top milking pail.....	3	.....	(For jacket or wet blanket		
Facilities for hot water or			allow 2; dry blanket or cov-		
steam..... 1			ered wagon, 1.)		
(Should be in milk house,					
not in kitchen.)					
Milk cooler..... 1					
Clean milking suits..... 1					
MILK ROOM.					
Location of milk room.....	2	.....			
Free from contaminating					
surroundings..... 1					
Convenient..... 1					
Construction of milk room.....	2	.....			
Floor, walls, and ceiling... 1					
Light, ventilation, screens 1					
Total.....	40	.....	Total.....	60	.....

Score for equipment..... + Score for methods..... = Final score.

NOTE 1.—If any filthy condition is found, particularly dirty utensils, the total score shall be limited to 49.

NOTE 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

636,073
225-8
B95c

Issued October 19, 1909.

United States Department of Agriculture,

BUREAU OF ANIMAL INDUSTRY.—Circular 152.

A. D. MELVIN, CHIEF OF BUREAU.

DIRECTIONS FOR THE HOME PASTEURIZATION OF MILK.

By L. A. ROGERS,

Bacteriologist, Dairy Division.

Milk delivered in the cities in the summer months frequently contains bacteria in such large numbers that it is not a safe food for children, especially for infants whose food consists entirely of milk. In many cities a special milk can be secured, but this is sometimes difficult and always involves additional expense.

Under such circumstances it is advisable to pasteurize all milk consumed by small children. The pasteurization should be done in such a way that disease-producing bacteria as well as those likely to produce intestinal disturbances are destroyed without at the same time injuring the flavor or the nutritive value of the milk. This may be accomplished in the home by the use of a simple improvised outfit.

Milk is most conveniently pasteurized in the bottles in which it is delivered. To do this use a small pail with a perforated false bottom. An inverted pie tin with a few holes punched in it will answer this purpose. This will raise the bottles from the bottom of the pail, thus allowing a free circulation of water and preventing bumping of the bottles. Punch a hole through the cap of one of the bottles and insert a thermometer. The ordinary floating type of thermometer is likely to be inaccurate, and if possible a good thermometer with the scale etched on the glass should be used. Set the bottles of milk in the pail and fill the pail with water nearly to the level of the milk. Put the pail on the stove or over a gas flame and heat it until the thermometer in the milk shows not less than 150° nor more than 155° F. The bottles should then be removed from the water and allowed to stand from twenty to thirty minutes. The temperature will fall slowly, but may be held more uniformly by covering the bottles with a towel. The punctured cap should be replaced with a new one, or the bottle should be covered with an inverted cup.

After the milk has been held as directed it should be cooled as quickly and as much as possible by setting in water. To avoid danger of breaking the bottle by too sudden change of temperature, this water should be warm at first. Replace the warm water slowly with cold water. After cooling, milk should in all cases be held at the lowest available temperature.

This method may be employed to retard the souring of milk or cream for ordinary uses. It should be remembered, however, that pasteurization does not destroy all bacteria in milk, and after pasteurization it should be kept cold and used as soon as possible. Cream does not rise as rapidly or separate as completely in pasteurized milk as in raw milk.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *October 6, 1909.*

○

636.073

U58

B95c

Issued April 28, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 153.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY;
UNIV. OF MICH.

MAY 19 1910

THE DISSEMINATION OF DISEASE BY DAIRY PRODUCTS, AND METHODS FOR PREVENTION.

I. MILK AS A CARRIER OF CONTAGIOUS DISEASE, AND THE DESIRABILITY OF PASTEURIZATION.

By G. LLOYD MAGRUDER.

II. THE IMPORTANCE OF A WHOLESOME MILK SUPPLY.

By JOHN R. MOHLER.

III. THE RELATION OF THE TUBERCULOUS COW TO PUBLIC HEALTH.

By E. C. SCHROEDER.

IV. INTERPRETATION OF RESULTS OF BACTERIOLOGICAL EXAMINATION OF MILK.

By L. A. ROGERS AND S. H. AYERS.

V. PASTEURIZATION, ITS ADVANTAGES AND DISADVANTAGES.

By M. J. ROSENAU.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY,
and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., January 24, 1910.

SIR: I have the honor to transmit herewith a series of papers dealing with the dissemination of disease by dairy products and methods for prevention. The first paper, by Dr. G. Lloyd Magruder, a medical specialist of Washington, D. C., who has had an important part in the efforts that have been made for the improvement of the local milk supply, discusses the general subject of milk as a carrier of contagious disease, reviews the history of the movement for a better milk supply for the city of Washington, and points out the desirability of pasteurization. Other papers follow by Doctors John R. Mohler and E. C. Schroeder, of this Bureau, dealing with the significance of the presence of tubercle bacilli and other contaminations in milk, and summarizing and bringing down to date some of their work and observations on these subjects. Messrs. L. A. Rogers and S. H. Ayers, of this Bureau, discuss the interpretation of the results of bacteriological examination of milk. At Doctor Magruder's request, Dr. M. J. Rosenau, formerly director of the Hygienic Laboratory of the United States Public Health and Marine-Hospital Service, has contributed a résumé of his work and views on pasteurization.

Within the last few years there has been great improvement in the direction of obtaining more wholesome and sanitary milk, but much yet remains to be done for the protection of the health of consumers. It is important that there should be not only legislation and competent official supervision, but a better understanding by the producers and the public of the dangers from contaminated dairy products and how these dangers can be avoided and overcome.

The classification of milk recommended by this bureau, as set forth in Circular 114, provides first for clean, raw milk, from healthy, tuberculin-tested cows, drawn and handled in a cleanly manner by healthy attendants, and transported, handled, and delivered to the consumer at a temperature not exceeding 50° F., and within the least possible time. When these conditions can not be met, then pasteurization should be required, under supervision, not for the purpose of making bad milk good, but to render milk of doubtful healthfulness safe. In the milk supply of a large city there will be, for some years at least,

a large proportion of the latter class of milk which must be utilized as food, and this can only be done safely by pasteurization or heating.

Finally, and no less important, milk should be properly handled after its arrival in the home. Great care should be exercised by the housewife and servants to keep milk, meat, and other foods in wholesome condition until they are consumed. A publication on the care of milk in the home is now in preparation.

As the accompanying papers contain much valuable information on the subjects with which they deal, I respectfully recommend their publication as a circular of this bureau.

Respectfully,

HON. JAMES WILSON,
Secretary of Agriculture.

A. D. MELVIN,
Chief of Bureau.

CONTENTS.

	Page.
I. MILK AS A CARRIER OF CONTAGIOUS DISEASE, AND THE DESIRABILITY OF PASTEURIZATION	7
Introduction	7
Report on typhoid fever in the District of Columbia	7
The milk law of 1895	9
Dairy inspection in Washington and other cities	9
The effect of water filtration on typhoid incidence	14
Investigation of water supplies of dairy farms	16
The Washington milk conference	18
Epidemics traced to the milk supply	20
British tuberculosis regulations	22
Pasteurization as a safeguard	23
The importance of keeping milk cool	25
Conclusion	26
II. THE IMPORTANCE OF A WHOLESOME MILK SUPPLY	28
Introduction	28
Tuberculosis	29
Evidence of transmission from cattle to people	30
Milk as a carrier of tubercular infection	31
Prevalence of tuberculosis among cows supplying milk to the District of Columbia	33
Danger from toxin in milk of tuberculous cows	33
Eliminate tuberculous cattle or pasteurize milk	33
Tubercle bacilli in other dairy products	34
Other diseases and conditions	36
Recommendations	37
III. THE RELATION OF THE TUBERCULOUS COW TO PUBLIC HEALTH	38
Introduction	38
Facts shown by experiments	39
The frequency of tubercle bacilli in milk	41
Pasteurization as an expedient	42
Some reasons for guarding against infected dairy products	43
IV. INTERPRETATION OF RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF MILK	46
Objects of bacteriological examinations	46
Sources and classes of bacteria in milk	46
Significance of numbers and methods	47
Influence of reaction of media on counts	47
Influence of temperature of incubation	49
Influence of age and temperature of milk	49
Significance of gas-forming bacteria	50
Significance of leucocytes and streptococci	51
V. PASTEURIZATION, ITS ADVANTAGES AND DISADVANTAGES	53

ILLUSTRATIONS.

	Page.
FIG. 1. Insanitary cow stable.....	16
2. An excellent and sanitary dairy barn.....	11
3. A milk house with insanitary location and surroundings.....	12
4. A clean and sanitary though inexpensive milk house.....	13
5. A dairy cow in filthy condition.....	14
6. A fine dairy cow in good, clean condition.....	15
7. Dirty sediment in bottom of bottle of milk.....	16
8. Milk sediment magnified.....	17
9. Diagram showing decrease in death rate of children in the District of Columbia following the enactment of the milk law of 1895.....	18
10. Culture plate showing bacteria in milk not cooled, kept at 60° F. for twenty-four hours.....	24
11. Culture plate from milk carefully drawn from washed cow and handled in a sanitary manner.....	25

THE DISSEMINATION OF DISEASE BY DAIRY PRODUCTS, AND METHODS FOR PREVENTION.

I. MILK AS A CARRIER OF CONTAGIOUS DISEASE, AND THE DESIRABILITY OF PASTEURIZATION.

By G. LLOYD MAGRUDER, A. M., M. D.,

Emeritus Professor of Materia Medica and Therapeutics, School of Medicine, Georgetown University, Washington, D. C.

INTRODUCTION.

The production, care, and food value of dairy products and their significance as causes and carriers of diseases have been subjects of study for more than twenty years in the city of Washington. This study has extended to milk, cream, ice cream, butter, and cheese. Numerous publications giving the results of these investigations have been issued. They have had a world-wide influence and are often quoted.

Three of the most important of these publications, with the issue of which the writer was intimately associated, are:

1. "Report on Typhoid Fever in the District of Columbia," submitted by the Medical Society of the District of Columbia to the Committee on the District of Columbia of the United States House of Representatives, June 14, 1894, and published by Congress as a congressional document in 1894.

2. "Sanitary Milk Production." Report of a conference appointed by the Commissioners of the District of Columbia. Issued August 20, 1907, by the United States Department of Agriculture as Circular 114 of the Bureau of Animal Industry.

3. "Milk and its Relation to the Public Health," issued in January, 1908, by the United States Treasury Department as Bulletin 41 of the Hygienic Laboratory of the Public Health and Marine-Hospital Service (revised January, 1910, as Bulletin 56).

REPORT ON TYPHOID FEVER IN THE DISTRICT OF COLUMBIA.

The report on typhoid fever was the outcome of the attention that was being called to the high death rate from typhoid in Washington, D. C. On motion of the writer the Medical Society of the District of Columbia appointed a committee, with him as chairman, to investigate the prevalence and causes of the disease. The other members of the committee were Drs. W. W. Johnston and C. M. Hammett.

The report of the committee showed, as the result of investigations which extended over five months, that typhoid prevailed to an alarming extent and that several factors were responsible for its occurrence: (a) Potomac water supply; (b) pollution of the soil with leakage from privies, from defective sewers, and from backing up of sewage from tidal movements; (c) drinking of well or pump water; (d) contaminated milk.

Among the recommendations of the committee, which were unanimously adopted by the Medical Society, were the construction of works for the filtration of the Potomac or Washington water—the only method of purification; the abandonment as rapidly as possible of all wells within the city limits; the repairing of defective sewers; the extension of the water supply and the sewers; the making of house connections to the same.

The views of the committee as to the unhealthfulness of well waters were fortified by the results of bacteriological examinations of water from 13 wells in the city of Washington, made by Dr. J. J. Kinyoun. The water from 9 of these wells was classed as bad, and from 2 as suspicious. It was recommended that the 9 wells be closed and that the remaining 4 be kept under observation.

In regard to the milk supply, the committee recommended the "careful inspection of all dairies in the District from which the milk supply is drawn and the enactment of a law by which no milk shall be sold in the District without a permit from the health office. The inspection should cover an examination at the dairies of all possible sources of infection, including the water supply."

It will be seen that pure milk and pure water, both in the city and at the farm, and the avoidance of contact with persons suffering with the disease, were the cardinal preventive measures recommended. The importance of these recommendations was immediately recognized. The United States Congress, as well as the city authorities, sought the aid of the Medical Society and individual members in framing remedial legislation.

That the recommendations made in 1894 were important and proper is attested by remarks made at the symposium on "The causes of typhoid fever in the District of Columbia," held, on motion of the writer, by the Medical Society, February 19 and 26, 1908. Dr. George M. Kober,^a professor of hygiene, Georgetown University, said that "every point developed in recent discussions, save the influence of domestic filters and water coolers, had received consideration before." Doctor Kober's investigation in 1895 confirmed in every particular the conclusions reached by the committee of the Medical Society in 1894, and developed two new facts, viz, the percentage of imported cases and the agency of flies in the transmission of the disease.

^a Washington Medical Annals, vol. 7, 1908, pp. 98, 99.

Dr. William C. Woodward, health officer of the District of Columbia, said:^a

The problem as stated above, "Why is typhoid fever more prevalent in the District of Columbia than in other communities?" was clearly the problem before the Medical Society in 1894, when it inaugurated the campaign against the disease, and the clear realization of the problem to be solved contributed very largely, no doubt, to making the work of that committee as thorough and the results as complete as they were. It may safely be said that, aside from the one or two new facts brought to light by Doctor Kober's investigations, and to which Doctor Kober has already referred, no material fact has been disclosed by any subsequent investigation that was not anticipated in the report of the Medical Society.

The contention for pure water, pure milk, and the avoidance of contact, outlined in 1894, as preventive measures against typhoid fever is further sustained in Bulletin 44 of the United States Public Health and Marine-Hospital Service, May, 1908, as follows (pp. 9 and 10):

Thus far our studies indicate that typhoid fever will cease to be a problem in any community having clean water, an uninfected milk supply, and in which cases of the disease are treated as dangerous and contagious.

In drawing up the conclusions and recommendations of this report we have had the benefit of consultation with the advisory board of the Hygienic Laboratory, composed of eminent scientists and sanitarians. This privilege is appreciated and we desire to acknowledge the help we have received from the members of the board collectively and individually.

THE MILK LAW OF 1895.

The first step toward carrying out the recommendation of the committee of 1894 was the passage of an act by the United States Congress, approved March 2, 1895, which required the inspection of all dairy farms and a permit from the health officer of the District of Columbia before milk could be sold for consumption in the city of Washington. This requirement applied not only to the farms in the District of Columbia, but also to those in the States supplying milk to Washington. This made the city of Washington the first in the country to extend inspection to the dairy farms as well as to the milk depots in the city. The reports of these inspections are now recorded upon cards known as "score cards."

DAIRY INSPECTION IN WASHINGTON AND OTHER CITIES.

The use of score cards has proved to be very popular as well as valuable. Many States and cities have adopted them. The United States Department of Agriculture reports that it has supplied them to about 300 cities in 39 States, and that they are being widely used. These figures, however, do not represent the full extent of the use of the score-card system, as it has been formally adopted by the state health authorities of four or five States and is being introduced by them in

^a Washington Medical Annals, vol. 7, 1908, p. 103.

the cities under their supervision. The provincial board of health of Ontario, Canada, has recommended its use by all the local boards of health in its jurisdiction. Further, the score card is being used commercially by a number of large wholesale milk dealers for the purpose of ascertaining the methods used among the dairies from which they buy their supplies.

It has been found in many instances that the dairyman upon the second inspection of his dairy has made desirable improvements to secure a higher rating. Many dealers demand a high rating before they will purchase the output of a dairy. As a result of these require-

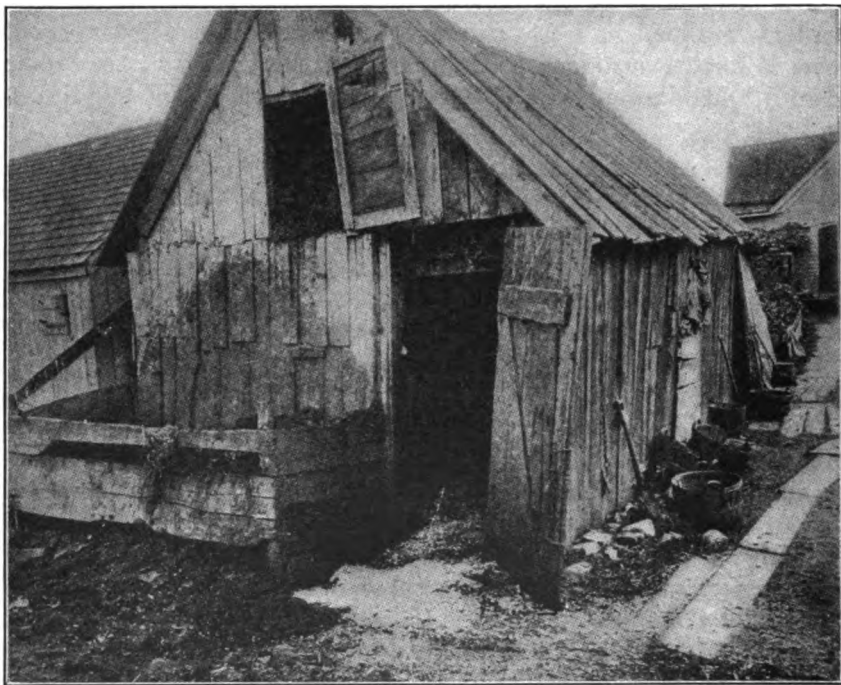


FIG. 1.—Insanitary cow stable. Wholesome milk can not be produced in such a place.

ments much milk is delivered to the distributing depots with less than 2,500 bacteria to the cubic centimeter.

This inspection has revealed many unfavorable conditions both at the farm and at the city depot. Insanitary houses, milk houses, and barns were common. (See figs. 1 and 3.) The attendants upon the cattle were careless of their personal habits and frequently were suffering from disease, sometimes of a contagious character. Cattle were frequently found covered about their flanks, legs, udder, and tail with manure and other dirt, which readily dropped into the pails while milking was being done. (See fig. 5.) Cattle were many times found suffering from constitutional diseases as well as local

affections of the udder. Flies swarmed about the premises. Frequently on the surface of the milk in the pails floated dead and dying flies. With the knowledge now available of the habits of the fly, this condition alone is a most dangerous source of milk infection. The presence of sediment in the milk containers (as shown in fig. 7) was a common occurrence. This is especially dangerous, since it has been shown that the ingredients are pus cells, blood, epithelium, barn-yard manure, and varied bacteria, including colon bacilli, and, as shown by Schroeder and Cotton,^a very commonly the tubercle bacillus.

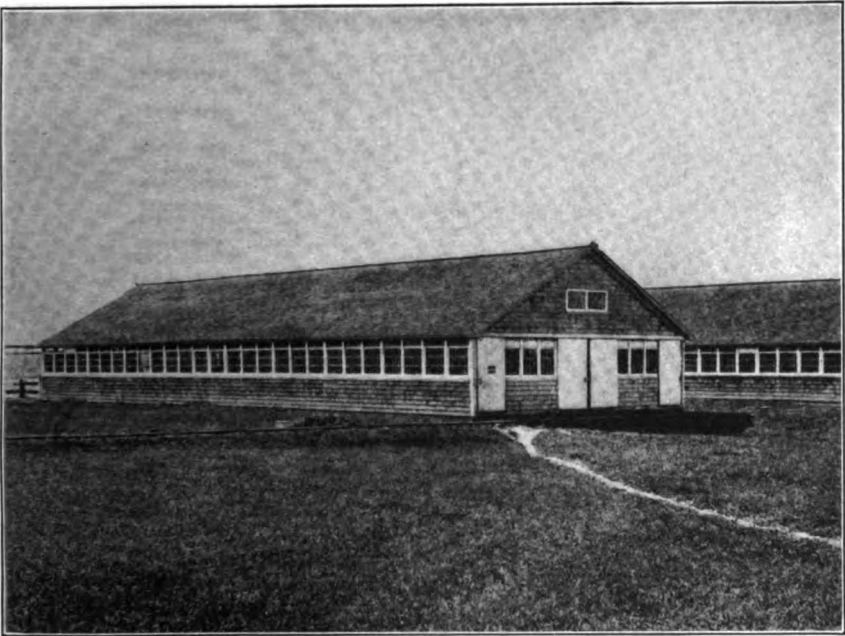


FIG. 2.—An excellent and sanitary dairy barn.

Few if any facilities were found for boiling the water to cleanse the utensils used in the handling and transportation of milk, the hands of the milkers, or the udders of the cows. Polluted water readily contaminates milk. This contamination rapidly multiplies at a temperature above 50° F. The knowledge which is rapidly being accumulated as to chronic carriers of the typhoid bacillus, and the common custom which prevails in rural communities of depositing human excreta upon the ground, frequently in close proximity to residences, barns, and water supplies, demand that the water supply on dairy farms should be frequently examined and carefully guarded

^a Bulletin 99 and Circular 118, Bureau of Animal Industry, Department of Agriculture.

against contamination. The location of the premises for the storage and the handling of dairy products in the city depots was frequently most objectionable and at times entirely unfit for such purposes.

The following are some results of one year's use of the score-card system of inspection at Indianapolis:

Dairies scored	717
Barns improved	381
New barns built	41
Milk rooms built or repaired	319
Visits made by request to advise about constructing new barns or repairing old ones	137



FIG. 3.—A milk house with insanitary location and surroundings.

The report of the official in charge says:

While at first we met with serious opposition, producer and dealer have become convinced that instead of persecution, the work is for their betterment.

Numbers have thanked us for insisting that they improve their conditions, stating that they do not see how they could have produced milk under the conditions they did.

The records of inspection as kept upon score cards show the result of intelligent inspection of the dairy farms supplying milk to Richmond from May, 1907, to May, 1908. The first inspection in May gave an average of 41.5 out of a possible 100; the inspection in April of the following year, twelve months later, gave an average of 72 for the same premises. This demonstrates a gain of nearly 100 per cent for the year. The improvement was steady throughout this time.

In the annual report of the Richmond, Va., health department for 1908 the dairy inspector in his report to the chief health officer

says: "The disposition among our dairymen to improve their plants is wonderful, and all speak highly of the work of the health department."

Washington City also furnishes an excellent illustration of the effects of intelligent inspection. The inspectors and the producer have learned to understand each other. Many of the farmers welcomed the criticisms and proceeded to remedy these defects, as it was found that much could be done at an insignificant outlay of time and money. Much higher scores were given in many cases upon the second inspection. At the meeting held September 22,

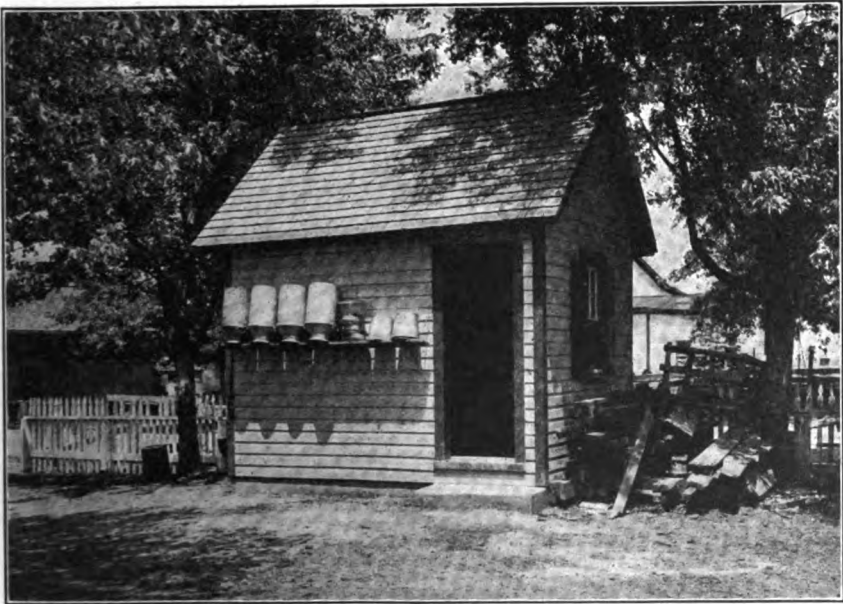


FIG. 4.—A clean and sanitary though inexpensive milk house.

1909, in Washington, of the Milk Producers' Association of Maryland, Virginia, and the District of Columbia, President Thomas in his address reminded the members of the association that "the day was past when the milk inspector was looked upon as an irreconcilable enemy."

Such expressions show the spirit with which intelligent inspection is met. This educational inspection means much to both producer and consumer. It contributes not only to the health of the families of both, but also to that of the dairy herd. It is a well-known fact that typhoid fever prevails to an alarming extent in rural communities. It has been found that it is two and a half times more prevalent in the counties of Maryland than in the city of Baltimore. Tuberculosis is also quite common in the country.

Dr. G. W. Goler, health officer of Rochester, N. Y., has had excellent results from dairy inspection. The death rate of children has been markedly decreased and the prevalence of milk-borne diseases has greatly diminished in that city.

Inspection has worked well; it should be perfected and extended. It should be assumed by state and municipal authorities and not left to the enthusiasm of public-spirited physicians and other citizens. The District of Columbia milk law of 1895 was not entirely satisfactory. Yet it is justifiable to claim that it promptly demonstrated the advisability of municipal and state control. Additional legislation to meet the demands of present-day knowledge is imperative.

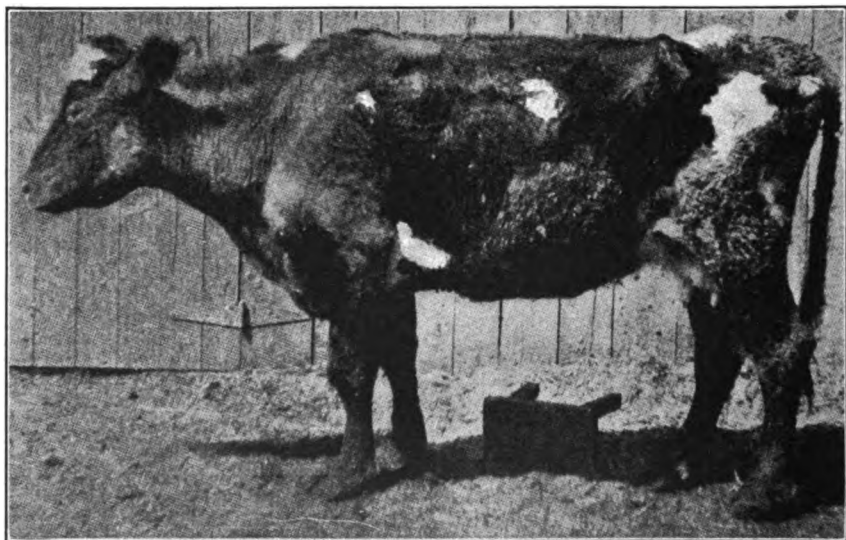


FIG. 5.—A dairy cow in filthy condition.

Dr. W. C. Woodward, health officer of the city of Washington, D. C., in Bulletin 41 of the Public Health and Marine-Hospital Service, says:

The death rate from diarrheal diseases among infants during the five-year period 1880 to 1884 was 162 per 100,000. During the next five-year period it was 168, and from 1890 to 1894 it was 175. In 1895 the milk law was enacted. From 1895 to 1899 the death rate fell to 135; from 1900 to 1904 it fell to 109, and in 1905 it was only 104, and in 1906, 1907, and 1908 only 97 per 100,000. [In 1909 it fell to 72.]

The diagram that accompanies Doctor Woodward's article (here reproduced as fig. 9) shows the above facts graphically.

THE EFFECT OF WATER FILTRATION ON TYPHOID INCIDENCE.

An important advance toward carrying out the recommendations of the report of 1894 was the completion of the filtration plant in 1905 for the Washington water supply. The efficiency of this plant has eliminated the water as a factor in the causation of typhoid fever. The reports of the engineer officers in charge show the following results:

Results of tests for Bacillus coli of 10 and 1 c. c. samples from filtered water reservoir and tap water from various parts of city.

Fiscal year.	Number samples examined.	Samples in which <i>B. coli</i> was positively determined.	
		Number.	Percentage.
1905-6.....	502	8	1.60
1906-7.....	1,630	52	3.18
1907-8.....	2,232	42	1.88
1908-9.....	2,294	15	0.67
1909-10 ^a	940	0	0.00

^a Five months only, July to November, 1909, inclusive.

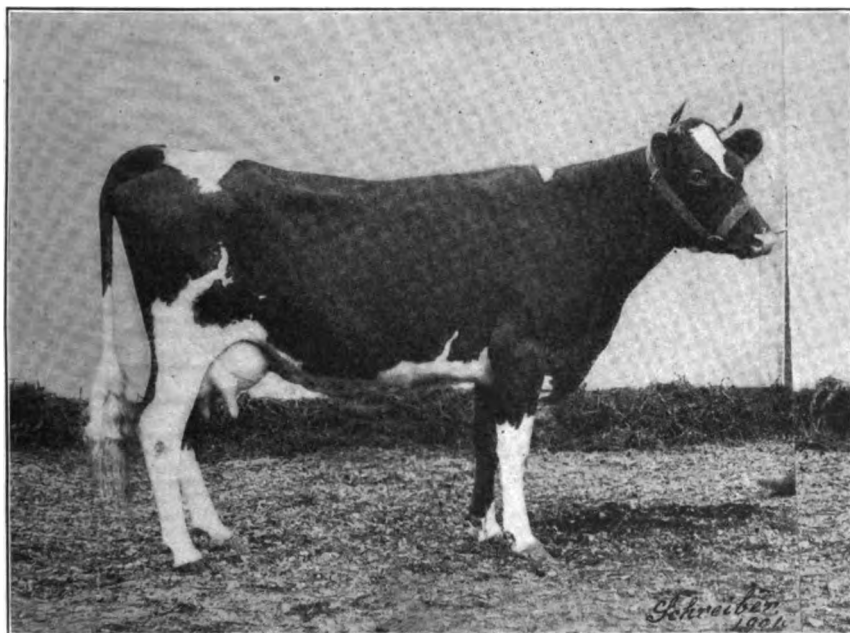


FIG. 6.—A fine dairy cow in good, clean condition.

The results of similar tests of unfiltered water for five months of 1909 showed that 28 out of 549 samples positively contained *B. coli*.

These results are confirmed by the series of check experiments conducted during September, October, and November, 1906, by the Bureau of Plant Industry of the Department of Agriculture, and those in charge of the filtration plant, and by repeated examinations by the Bureau of Chemistry of the Department of Agriculture, the Geological Survey, and the Hygienic Laboratory of the Public Health and Marine-Hospital Service. Washington can now use without fear water direct from the faucet. The occasional turbidity could easily be eliminated by providing for preliminary treatment during these times. This preliminary treatment would in nowise exert any dele-

terious influence. There is no need to resort to boiling the Potomac water nor to the use of bottled waters of questionable purity.

Contrary to every expectation, there was no diminution in the prevalence of typhoid fever following the completion of the filtration plant as compared with the few preceding years. Numerous investigations were undertaken and reports made; some covered conditions in the city, and others covered both the city and the dairy farms. Continued study convinced the writer that stricter attention must be paid to the conditions at the dairy farms, including their water supply, to which he had called attention in 1894.

INVESTIGATION OF WATER SUPPLIES OF DAIRY FARMS.

Through the efforts of the Secretary of Agriculture, every one of the approximately 1,000 farms supplying milk to Washington was



FIG. 7.—Dirty sediment in bottom of bottle of milk.

inspected by the Bureau of Animal Industry in the winter of 1906-7. The average score of these farms was as low as 45.03 out of a possible 100. On 60 of the farms, taken at random, bacteriological investigations of the springs and wells were made by the Bureau of Plant Industry. These were the first on record of an extended series of investigations of their kind.^a Doctor Kinyoun did make 6 such examinations in 1895, in 4 of which he found the water supply to be contaminated. Previously the analysis of waters was only chemical. The revelations were startling. Subsequently 290 more water supplies were examined by Dr. B. M. Bolton of the Bureau of Animal Industry, with equally astounding results.

^a Kellerman, Karl F. Bacteria of the dairy wells in the vicinity of Washington, D. C. Washington Medical Annals, vol. 6, 1907, p. 83.

The bacteriological examinations of the water supplies of the first 60 dairy farms showed that only 25 per cent were under the danger line—that is, if we take 500 bacteria to the cubic centimeter of water as the limit of safety; 30 per cent were suspicious, having above 500 bacteria to the cubic centimeter, and 45 per cent were positively unfit for use, as they showed the presence of sewage bacteria. The bacterial counts in some instances were as high as 27,000, though they were made in November and December—that is, in comparatively cold weather.

Since these bacteriological examinations were made similar examinations have followed in other cities and States, with almost identical

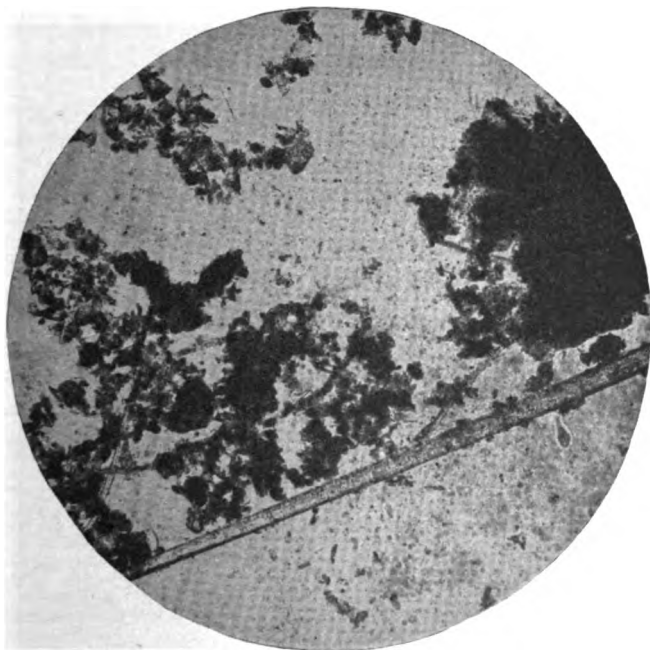


FIG. 8.—Milk sediment magnified. This sediment consists of cow dung, hair, bacteria, etc.

results. Up to August, 1908, 386 such examinations had been made on the dairy farms around Chicago. Doctor Evans, the health officer, was so impressed with the bad conditions that he decided to continue the investigations. Professor Prescott, associated with Professor Sedgwick, reported upon 240 farms in Massachusetts. While the tests showed far better conditions than those in other States, enough information as to bad conditions was obtained to warrant Professor Prescott in recommending these examinations to be made annually. Bulletin 154 of the Bureau of Plant Industry, United States Department of Agriculture, by Kellerman and Whittaker, issued November 6, 1909, gives the results of the examination of the water supplies of 79 farms in Minnesota. Twenty were found to be good, and 59 were

polluted, 23 of the farms examined showing a record of typhoid fever. On 5 of them the water was not polluted, on the other 18 the water was polluted.

These records support the contention for the necessity of bacteriological examinations of these water supplies. Impressed with these revelations, Dr. M. P. Ravenel has urged the inspection of the water supplies of all farms in Wisconsin. It is expected that many other examinations will be made in the near future.

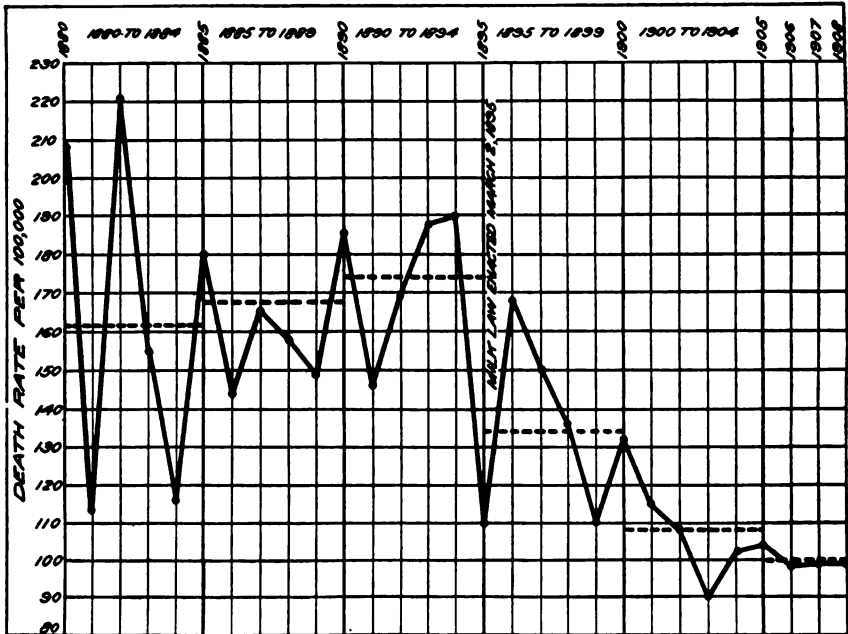


FIG. 9.—Diagram showing decrease in death rate of children in the District of Columbia following the enactment of the milk law of 1895. Dotted lines show averages. (In 1900 the death rate fell to 72.)

THE WASHINGTON MILK CONFERENCE.

The conditions on dairy farms supplying milk to the city of Washington were brought to the attention of the Commissioners of the District of Columbia, and the result was the appointment of the Washington milk conference, a report of which was published as Circular 114 of the Bureau of Animal Industry, before referred to.

This circular shows the dangers of raw milk and the value of pasteurization. The following abstract in an editorial published in the *London Lancet*^a gives a very excellent idea of some of the features of this report:

The Agricultural Department at Washington has issued a volume of reports containing the results of the conference of experts called together by the department to con-

^a The *Lancet*, Vol. II, 1907, No. XIII (Vol. CLXXIII, No. 4387), pp. 936, 937.

sider the various questions now agitating the country in regard to the purity of the milk supply. The conference consisted of 35 recognized experts in the study of the questions involved. This volume will be the recognized text-book of the health authorities of this country for the present, as it carries the weight of authority of these experts and the indorsement of the Department of Agriculture. In brief, these experts agreed upon a definite milk programme and have recommended that public safety should be assured by legislation establishing three classes or grades of milk—namely, certified, inspected, and pasteurized. They would not tolerate any trifling with the public in the sale of so-called certified milk. They would require that such milk should come from dairies subject to periodical inspection and that the milk should be frequently analyzed; that the cows should be proved to be free from tuberculosis by the tuberculin test and from all other communicable diseases; that the milk should be handled by persons free from infection; that the milk should contain not more than 10,000 bacteria to the cubic centimeter; and that it should not be more than twelve hours old when delivered to the consumer. The conference would permit the sale of such milk raw under the label "certified," and would allow the sale raw, under the label "inspected," of milk that had been similarly produced but did not quite come up to the requirements for certification, provided that such milk came in all cases from tuberculin-tested cows and did not contain more than 100,000 bacteria to the cubic centimeter. Such milk, and only such, do these experts believe should be sold raw; all other milk should be pasteurized. The declaration of the conference is as follows: "Milk from the dairies not able to comply with the requirements specified for the production of milk of classes 1 [certified] and 2 [inspected] is to be pasteurized before being sold," and then sold under the designation "pasteurized milk." All milk of an unknown origin shall be placed in class 3 and shall be subjected to clarification and pasteurization at central pasteurization plants which shall be under the personal supervision of officers of the health department. The term "pasteurization" is explained to mean the heating of the milk to a temperature of 150° F. for twenty minutes, or 160° for ten minutes, and immediate cooling to 50°.

The writer was so impressed with the reception and the influence for good of the report of the Washington milk conference that in June, 1907, he suggested to Mr. Roosevelt, then President of the United States, both at a personal interview and in the following letter, that an investigation be made of the milk industry from the farm to the consumer.

WASHINGTON, D. C., *June 11, 1907.*

SIR: In view of the agitation that is now going on in Europe and this country with reference to the question of the influence of milk upon infant mortality, as well as the causation of tuberculosis, typhoid and scarlet fevers, and diphtheria, I would respectfully suggest that you direct the Bureau of Public Health and Marine-Hospital Service to make a thorough investigation of the milk industry in the District of Columbia from the farm to the consumer. For this purpose the Bureau should be empowered to have the cooperation of other departments of the Government, and proper credit should be given for such aid.

Several foreign governments have recently ordered such investigations, and the reports are frequently quoted by writers in the United States upon these subjects. These writers have expressed many divergent views.

The recent investigation conducted by the Bureau of Public Health and Marine-Hospital Service into the cause of the prevalence of typhoid fever in the District of Columbia, which report, including an examination of the milk supply in the city of Washington, has been printed and will be issued in a few days, and the work of the Department of Agriculture concerning the milk supply at the farms have shown that

many lives could have been saved and numerous cases of disease avoided by more careful attention to the health of the dairyman as well as the cows, and the handling of the milk at the farm, in transportation, and distribution in the city.

Much valuable information has been accumulated by both departments, which can be consolidated and developed so as to be utilized as a standard not only for the District of Columbia, but for the United States. This standard is very essential at the present time, and, with the facilities at the disposal of the United States Government, should have equal weight with that of any other government.

It can be readily shown that much can be done to improve the milk supply without materially adding to the cost to the farmer and thus to the consumer.

The report of such an investigation should be freely illustrated that it may serve as an educational document.

Very respectfully, yours,

G. LLOYD MAGRUDER, M. D.

The PRESIDENT.

President Roosevelt grasped the importance of the subject and immediately directed an investigation, which was conducted by recognized experts in the United States Department of Agriculture, the United States Public Health and Marine-Hospital Service of the Treasury Department, and Dr. W. C. Woodward, health officer of the District of Columbia. The report of the various experts who elaborated the work of the Washington milk conference is published as Bulletin 41 of the Public Health and Marine-Hospital Service, and is widely recognized as the most valuable work ever issued by the United States Government on public health. In it all the views advanced by the Washington milk conference are positively indorsed.

EPIDEMICS TRACED TO THE MILK SUPPLY.

In May, 1901, Dr. George M. Kober reported a series of 330 outbreaks of infectious diseases that were spread through the milk supply. These outbreaks consisted of 195 epidemics of typhoid fever, 99 of scarlet fever, and 35 of diphtheria. In 148 of the 195 epidemics of typhoid fever there is evidence of the disease existing at the farm.

Kober says:

It is interesting to note that of the 330 epidemics analyzed by me, 243 have been recorded by English authors, 52 by American, 14 by German, 11 by Scandinavian, and 5 each by French and Australian writers. This is probably due to the fact that the English and Americans usually consume raw milk, while on the Continent the milk is rarely used without being boiled.

Surgeon Trask, of the United States Public Health and Marine-Hospital Service, in Bulletin 41, has added a large number of similar outbreaks to Doctor Kober's list.

The occurrence of over 600 cases of streptococcus sore throat in Stockholm in the early part of 1908 was traced to a streptococcus abscess in the udder of a cow in a herd that furnished milk to those who became infected. The significance of streptococci in market milk requires careful and immediate investigation.

In the fall of 1908 over 50 cases of typhoid fever in Washington, D. C., were traced to the supply of milk from a single farm. The owner was a bacillus carrier. The supply of milk from this farm was stopped.

From the well-known prevalence of rural typhoid, the presence of bacillus carriers, and the existence of contaminated water supplies at many farms which can readily contaminate milk, it seems that milk is a far greater factor in keeping up the typhoid rate in Washington than a number of writers have been willing to admit. The writer has always contended that dairy products were the principal sources of the disease. In view of recent investigations, he reasserts his position.

The recent outbreak of typhoid fever in August, 1909, in Cassel, Germany, is a striking example of the results of contaminated milk. The circumstances were stated by Mr. E. Berliner in a paper read before the District of Columbia Association for the Prevention of Tuberculosis, as follows:

In the latter part of August of this year several cases of typhoid fever made their appearance in a home for babies, but, strange to say, the fever did not attack the children but several of the nurses, and it was soon ascertained that the milk consumed in the home had been partaken of in a raw state by the nurses, but by the children only after having been scalded. In the meantime typhoid cases were reported from all over the city, and the wide-awake health officer of Cassel, Privy Medical Counsellor Doctor Heinemann, soon discovered that in every instance the families in which the fever developed obtained their milk from one and the same dairy, the "Sanitäts Mölkerei," which distributed about 7,000 liters per day. This dairy was kept scrupulously clean and was looked upon as a model of its kind, with the cognomen "Sanitary" attached to its name as a catchy advertisement. The dairy received its milk from over 30 farms, but had never paid much attention to inspection or to bacteriological tests. When the typhoid outbreak assumed the aspect of an epidemic, Doctor Heinemann ordered the "Mölkerei" closed and publicly advised the inhabitants of Cassel to drink only scalded milk. But for many unfortunate citizens the advice came too late, and over 300 cases, with the usual mortality, resulted from the drinking of the infected milk in the raw state.

And here a deplorable misconception of Doctor Koch's attitude toward the question of bovine tuberculosis, as affecting human beings, should be mentioned. A prominent sanitarian in Cassel told me that whereas formerly everybody in Germany drank his milk scalded or boiled, many now drank it in the raw state because, with Koch's defense of milk from tuberculous cows and the persistent opposition of many physicians to pasteurization for theoretical reasons, raw milk is by many hailed as the model food for man, woman, and child. And those ill-starred citizens whose vitality was already low and who would therefore constitute a most excellent soil for the development of milk-bred diseases, would fall ready victims to one of the most dangerous and death-dealing theories which by, or with the sanction of, medical men was ever offered to a confiding humanity. Doctor Heinemann found that in every case it was only those members of the household who had partaken of "Mölkerei" milk in the raw state who became sick, while all the others who drank the milk scalded or boiled remained entirely well.

And now as to the primary cause of the epidemic. The different farms which supplied the "Mölkerei" with milk were investigated. Doctor Heinemann's medical

agents found no typhoid cases on the premises, nor did they take the time to search for chronic bacilli carriers, but they did find the wells on several of the farms in most suspicious condition, and, furthermore, that water from streams, polluted by human settlements for long distances, had in some cases been used for rinsing the milk cans. Whosoever has studied dairy conditions in Germany and knows of the untold filth on the farms, the dirty stables and yards, and the ignorance and the apathy regarding sanitation, not only among the peasants but even among some of the very best classes of people, does not wonder at such an epidemic, but rather that there are not many more similar ones. No doubt there are, but they do not become known, the knowledge of them being withheld by jealous municipalities.

I asked Doctor Heinemann what he proposed to do to prevent further troubles. He said that the "Sanitäts Molkerei" was still closed and would not reopen until an up-to-date pasteurization plant had been installed. They would also introduce a system of sterilizing all milk cans from the farms with live steam, and send them back sealed, and they are to remain sealed until refilling time—an excellent idea.

Though the cattle of America are not as commonly affected with tuberculosis as those of Europe, the Bureau of Animal Industry of the United States Department of Agriculture reports that 33 per cent of the centrifuge slime examined at public creameries showed tubercle bacilli. This fact, in view of the publications of Schroeder and others, showing that tubercle bacilli rise in milk as freely with the cream as they sink with the sediment, is of great importance.

The significance and the effect of the presence of tubercle bacilli in dairy products have deeply interested investigators in many countries. The British Royal Commission on Human and Animal Tuberculosis takes the position that bovine tuberculosis is a positive factor in causing tuberculosis in human beings, and its "Third Interim Report," London, 1909, is mainly a repetition and a confirmation of the work done by Dr. E. C. Schroeder and Mr. W. E. Cotton, of the Bureau of Animal Industry, in 1906 and 1907. (See Bulletin 99, and Circular 118, Bureau of Animal Industry.)

BRITISH TUBERCULOSIS REGULATIONS.

In view of the above-mentioned report by the British Royal Commission, the Board of Agriculture and Fisheries of Great Britain have issued the "Tuberculosis Order of 1909," dated May 27, 1909, from which the following is taken:

1. I am directed by the board of agriculture and fisheries to send to you for submission to your local authority the inclosed copy of the tuberculosis order of 1909, which will come into operation on the 1st of January, 1910.

2. As your local authority are doubtless aware, the subject of tuberculosis in man and in animals, and the relations between the disease in human beings and in animals, has been under careful investigation during recent years in this country and abroad, and various phases of the question have been inquired into by successive royal commissions. So far as regards the possibility of the transmission of the disease from affected bovine animals to man, the board are satisfied that it must now be accepted as a fact that tuberculosis is transmissible by the agency of milk used for human consumption. The local government board concur in this view, and a bill was introduced in the House

of Commons by the president of the local government board on the 25th instant designed, *inter alia*, to afford protection to the public health from the risk of the spread of tuberculosis by the means of milk used for human consumption.

3. In considering the question in relation to animals, the fact that the disease is communicable to man by milk has a material bearing on the measures to be adopted. Any action which results in the reduction in the number of tuberculous bovine animals in the country must reduce the risk of the spread of tuberculosis amongst the community, and if it were possible to eradicate from this country the disease in animals, a material step forward would have been taken in the campaign against the disease in man.

PASTEURIZATION AS A SAFEGUARD.

Even though the danger of contracting tuberculosis from dairy products can be eliminated if we can obtain milk from healthy cows, there still remains the danger of contracting other diseases from contaminated milk. Milk can be made safe, however, by the proper application of heat. There are two terms applied to the results of heating milk, pasteurization and sterilization. These two terms must not be confounded; the former is a process that requires the application of a much lower degree of heat than is effective for the latter. Sterilization means the killing of all the germs that may be present in milk. Pasteurization means the destruction of the disease germs that are of more common occurrence in it, such as those of tuberculosis, typhoid fever, diphtheria, etc. The investigations of Dr. M. J. Rosenau especially have shown that the common or pathogenic bacteria are unable to retain their life and virulence when they are exposed to a temperature of 60° C. or 140° F. for a period of twenty minutes, and that the value of milk as an article of food is not perceptibly affected by the designated temperature. Professor Kastle, of the University of Virginia, after extensive investigation, concluded that the designated temperature, maintained for a sufficient time to destroy the disease germs of common occurrence in milk, has no deleterious effect on its nutritive value. Thousands of children under the eyes of careful and competent observers have been reared successfully upon milk so treated without the slightest signs of scurvy or rickets. The temperature required for sterilization does destroy the enzymes and impair the nutritive value of milk. This emphasizes the necessity for a proper appreciation of the processes, pasteurization and sterilization.

It must be kept in mind that the advocates of pasteurization do not countenance the use of unclean or old milk; on the contrary, they insist that pasteurization should be applied, not to correct sensible conditions of an objectionable character, but simply as a measure of safety against the dangers from milk which no other precautions can obviate. Furthermore, pasteurization should be practiced under proper supervision, and that form of so-called pasteurization which is to some extent commercially practiced, during which

milk is heated to an unnecessarily high temperature for barely a fraction of a minute, should be emphatically discountenanced. Health officers should be provided with properly equipped laboratories to keep constant check upon the output of pasteurizing plants. Progressive men in the distribution of milk, cream, and ice cream employ skilled bacteriologists. All milk, whether pasteurized or not, should be consumed as soon as possible after milking.

It frequently happens that properly pasteurized milk can not be secured on the market. The observance of the following directions

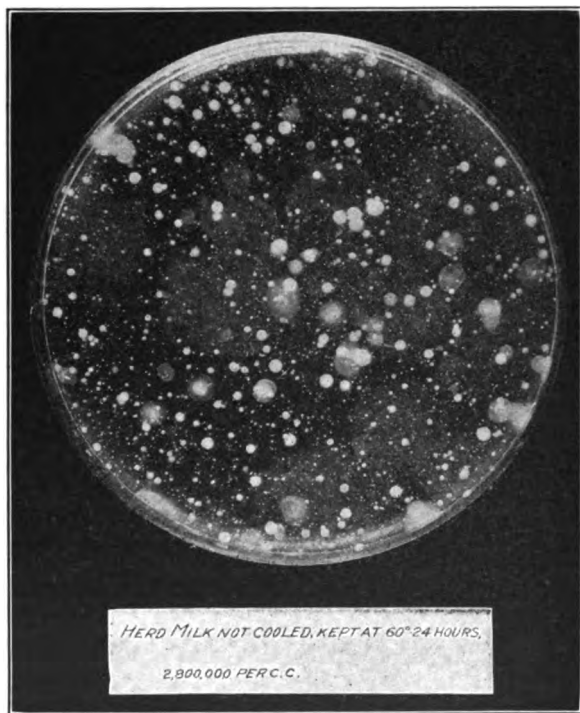


FIG. 10.—Culture plate showing bacteria in milk not cooled, kept at 60° F. for twenty-four hours. Numerous colonies; 2,800,000 bacteria per cubic centimeter.

for the home pasteurization of milk, by L. A. Rogers,^a of the Bureau of Animal Industry, can then be practiced:

Milk is most conveniently pasteurized in the bottles in which it is delivered. To do this use a small pail with a perforated false bottom. An inverted pie tin with a few holes punched in it will answer this purpose. This will raise the bottles from the bottom of the pail, thus allowing a free circulation of water and preventing bumping of the bottles. Punch a hole through the cap of one of the bottles and insert a thermometer. The ordinary floating type of thermometer is likely to be inaccurate, and if possible a good thermometer with the scale etched on the glass should be used. Set the bottles of milk in the pail and fill the pail with water nearly to the

^a Circular 152, Bureau of Animal Industry, Department of Agriculture.

level of the milk. Put the pail on the stove or over a gas flame and heat it until the thermometer in the milk shows not less than 150° nor more than 155° F. The bottles should then be removed from the water and allowed to stand from twenty to thirty minutes. The temperature will fall slowly, but may be held more uniformly by covering the bottles with a towel. The punctured cap should be replaced with a new one, or the bottle should be covered with an inverted cup.

After the milk has been held as directed it should be cooled as quickly and as much as possible by setting in water. To avoid danger of breaking the bottle by too sudden change of temperature, this water should be warm at first. Replace the warm water slowly with cold water. After cooling, milk should in all cases be held at the lowest available temperature.

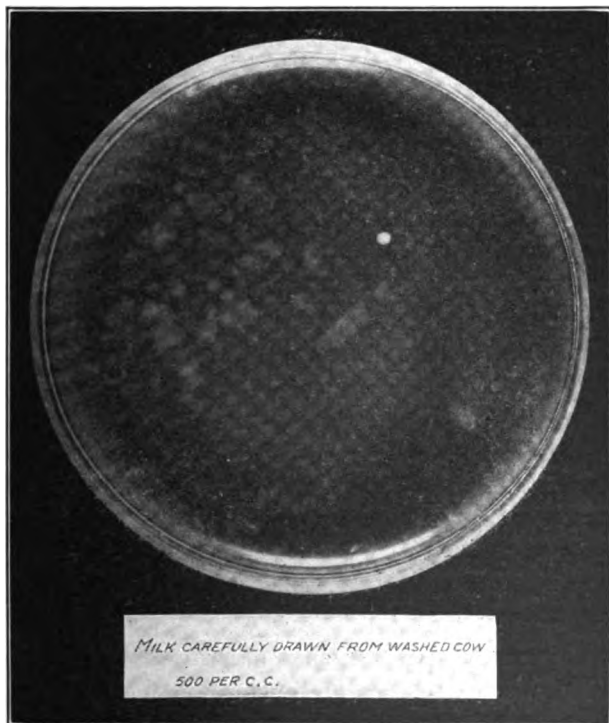


FIG. 11.—Culture plate from milk carefully drawn from washed cow and handled in a sanitary manner. Only a single colony, and but 500 bacteria per cubic centimeter.

This method may be employed to retard the souring of milk or cream for ordinary uses. It should be remembered, however, that pasteurization does not destroy all bacteria in milk, and after pasteurization it should be kept cold and used as soon as possible. Cream does not rise as rapidly or separate as completely in pasteurized milk as in raw milk.

THE IMPORTANCE OF KEEPING MILK COOL.

The cooling of milk and keeping it at a temperature not above 50° F., both at the farm and until used, is as important as raising it to a proper temperature for pasteurization. The importance of cleanli-

ness and cooling is well illustrated by figures 10 and 11. It is well known that the colon and typhoid bacilli, as well as other bacteria, proliferate rapidly in milk as soon as the temperature rises above the 50° F. line. This fact helps to explain the greater prevalence of typhoid fever in winter in localities where the temperature goes above 50° F. for any prolonged period, as few milk producers and dealers use ice to keep milk cool during the winter months.

The winter of 1889-90 was the warmest known in Washington for fifty years. The winter of 1908-9 was also unusually warm. The Weather Bureau of the United States Department of Agriculture reports the mean temperatures for these seasons, together with the normal temperature, for comparison, as follows:

Temperatures at Washington, D. C., for periods shown.

Data.	December.	January.	February.
	°F.	°F.	°F.
Mean temperature, 1889-90.....	45.6	43.8	43.4
Mean temperature, 1908-9.....	36.8	36.0	43.0
Normal temperature (33 years).....	36.1	32.9	34.5

Typhoid fever prevailed to a marked extent during both of these seasons. But little, if any, ice formed in the vicinity of Washington. In every other year ice 4 inches thick could have been harvested.

CONCLUSION.

If the lessons taught by these observations be heeded, a great step will be made toward the control of milk-borne infections. Dollars spent by the thousand for prevention will save millions needed for the care of those afflicted with disease, to say nothing of the days of suffering that will be avoided.

It can no longer be doubted that dairy products—and this term includes milk, cream, ice cream, butter and cheese—are excellent culture media for pathogenic bacteria. Outbreaks of typhoid fever, scarlet fever, diphtheria, sore throat, and intestinal disorders of children have been definitely traced to contaminated milk. The proofs of the danger from tubercular infection of these products are accumulating daily. The opportunities for such infection are manifold. With the greatest vigilance on the part of trained inspectors and the greatest care on the part of the householder this infection can not be entirely prevented. The householder also has a duty to perform to protect milk from contamination after it has been delivered.

Of course the carrying out of the recommendations for the production and delivery of more sanitary milk entails additional expense at the farm and the city depot. But the receipt of a single additional cent for a quart of milk would justify many improvements by the

producer and the seller. A single case of sickness or a funeral resulting from contaminated milk would cost far more than the slight additional price of better milk for a long period.

Under these circumstances there should be no question about demanding that milk should be produced under conditions that would entitle it to be entered under class 1 (certified milk) or class 2 (inspected milk) as prescribed by the Washington milk conference, or, in case it does not conform to the requirements for these classes, that it should be efficiently pasteurized (class 3).^a To produce milk under any of these classes rigid inspection is required.

The prices that must be charged for the first class make it almost impossible for the man of moderate means to avail himself of such milk. Class 2 can be produced at a lower price, but would still cost more than ordinary milk. Hence the masses must resort to the milk of class 3. With the precautions suggested, they would reasonably be assured in the use of this milk of a safe and wholesome supply at but a trifling advance in the price.

^a This classification, prepared by Dr. A. D. Melvin, Chief of the Bureau of Animal Industry, and approved by the Washington milk conference, is more fully described in Circular 114 of the Bureau of Animal Industry.

II. THE IMPORTANCE OF A WHOLESOME MILK SUPPLY.

By JOHN R. MOHLER, V. M. D.,

*Chief of the Pathological Division, Bureau of Animal Industry,
United States Department of Agriculture.*

INTRODUCTION.

The reasons for securing a supply of pure and wholesome milk are so numerous and so important that the public should become acquainted with some of the more essential of them in order that assistance may be rendered in bringing about a satisfactory improvement. Public health demands the purity of all milk and milk products. Next to bread, milk is more extensively used as an article of diet than any other foodstuff. It forms a portion of the food of almost every person on practically every day of the year. Furthermore, unlike many other articles of diet, milk is consumed in most cases in an uncooked state, making it a very dangerous food should it perchance contain any deleterious organisms. Not only is milk a very suitable medium for almost every description of germ life which may gain access to it in its journey from the cow to the consumer, but it may also become contaminated while still in the udder through infectious or poisonous material present in the cow herself. In this paper, however, consideration will be given only to the latter aspect of the subject.

In this connection it will be necessary to keep in mind the requirements of an awakened public for a clean and wholesome milk, as well as the effect of any unreasonable or irrational demand upon the producer, which may cause him heavy losses or even to discontinue his business. It will also be apparent that in order to produce milk in compliance with the requirements hereafter described certain precautions must be taken, which will necessarily entail additional expense upon the producer of this higher grade of milk. The customer must therefore expect to pay his portion of any legitimate advance in the cost of production, and such increase in the price of milk due to its improved quality should be considered as money well expended.

Moreover, good milk of safe quality can not be had without a realization on the part of the farmer, the transportation agent, the dairyman, and the housewife of the danger in utilizing old, warm, or dirty milk. Education is therefore an important factor in the improvement of the milk supply, which can not be accomplished through laws and regulations alone. In view of these facts, it is recommended that the subject be taught in the schools, that popular

articles be frequently prepared for the press, that lectures and demonstrations be given in towns and townships, that pamphlets in plain language be prepared by the health officer for general distribution, and especially that rules and suggestions, with reasons therefor, be placed in the homes of dairymen and dairy attendants.

TUBERCULOSIS.

Tuberculosis is probably the most important disease of cows from the standpoint of public health, and it is also the most prevalent. When Koch first discovered the cause of tuberculosis and combined the announcement of his discovery with the statement that he considered the affection identical in both man and cattle, this view was accepted by scientists as well as by the general public. His subsequent announcement in 1901 to the effect that this disease was different in man and in cattle, and that there was no practical need for preventing the use of the products of tuberculous animals for human food, was the cause of much rejoicing among those who were only too glad to grasp at any idea which would tend to separate the disease in man and in cattle, forgetting that bovine tuberculosis is also a dangerous disease to other cattle in the herd, and should be stamped out for this reason aside from any danger to man.

As a result of this radical statement of Koch's, which was based upon incomplete and unsatisfactory evidence, several government commissions were appointed in different countries, and many private and public scientists immediately took it upon themselves to solve the question raised by that investigator. The results of these experiments were so strikingly similar that it is now the generally accepted opinion among scientists that people, especially children, may become infected with tuberculosis from cattle. It is not known to what extent such infection occurs, nor is it possible to obtain any definite percentage by the method formerly adopted of looking for the primary lesions in the intestinal canal, although much statistical evidence is recorded, showing that even by these figures primary intestinal tuberculosis of children has been observed in from 2 per cent (Bovaird) to as high as 45.5 per cent (Heller) of the tuberculous cases examined. Evidence which must be considered conclusive has been obtained by the Bureau of Animal Industry, as well as by Ravenel and a number of French investigators, showing that tuberculous infection may take place through the intestinal tract without leaving any lesion in the abdominal cavity, the first alteration being found in the lungs or the thoracic glands. Therefore the presence of pulmonary tuberculosis in infants without intestinal lesions is no indication that the disease was not transmitted by the food, and the statistics above referred to are thus shown to be below the true percentage of cases of tuberculosis of intestinal origin.

EVIDENCE OF TRANSMISSION FROM CATTLE TO PEOPLE.

These figures, however, do not give any satisfactory idea as to whether the bacilli entering the intestines originated from human or bovine sources. Owing to this fact it follows that the only way of determining the infection of people by bacilli of the bovine type is to study the lesions in the body of as many cases of human tuberculosis as possible. Already we have sufficient data to give us some idea of the extent of tuberculosis of the bovine type in children, without considering the numerous cases of direct transmission recorded by many physicians, especially of instances of butchers and others receiving accidental infections of the skin with the bovine organism. Moreover, according to Von Behring, the question of infection in man usually goes back to childhood, as he believes that many of the cases of pulmonary tuberculosis in adults are of intestinal origin, infection having occurred primarily through the intestinal tract by drinking tuberculous milk during infancy and having remained latent until adult life. As vital statistics show that 14 out of every 100 people that die succumb to tuberculosis, while of the remaining 86 more than one-half show lesions of tuberculosis on post-mortem, although dying from some other cause, the foregoing statement of Von Behring is also practically pertinent in regard to the relation of human tuberculosis to the milk supply, especially in connection with the results of those investigators who have studied market milk and found from 2.7 to 55 per cent of the samples examined to contain tubercle bacilli.

Since direct experiments upon human beings are out of the question, the finding of the bovine type of tubercle bacillus in human lesions is the most direct and positive proof that tuberculosis of cattle is responsible for a certain amount of tuberculosis in the human family. Numerous experiments with this object in view have already proved this fact. Thus, the German Commission on Tuberculosis examined 56 different cultures of tubercle bacilli of human origin and found 6 which were more virulent than is usual for human tubercle bacilli, causing marked lesions of tuberculosis in the cattle inoculated with them, and making over 10 per cent of the cases tested that were affected with a form of tuberculosis which, by Koch's own method, must be classified as of bovine origin. The bacilli, with the exception of a single group, were all derived from the bodies of children under 7 years of age, being taken from tuberculous ulcers in the intestines, the mesenteric glands, or from the lungs.

In a similar series of tests conducted by the British Royal Commission on Tuberculosis, 60 cases of the disease in the human were tested, with the result that 14 cases were claimed by this commission to have been infected from bovine sources. Ravenel reports that of 5

cases of tuberculosis in children 2 received their infection from cattle. Theobald Smith isolated bovine bacilli in 12 out of 28 tuberculous cervical lymph glands and in 1 case of tuberculous meningitis. He estimates that from 25 to 50 per cent of the cases of human tuberculosis starting in the cervical and mesenteric lymph glands are bovine in origin. Park has recently found 6 cases of bovine infection out of 35 cases of generalized tuberculosis of infants, and 10 cases due to the bovine type of bacillus out of 35 cases of surgical tuberculosis, or altogether about 23 per cent of these cases in children due to bovine infection. Of 4 cases of generalized tuberculosis in children examined in the Biochemic Division of the Bureau of Animal Industry 2 were found to be affected with very virulent organisms, which warranted the conclusion that such children had been infected from a bovine source. The Pathological Division of the same bureau has likewise, out of the 9 cases of infantile tuberculosis examined, obtained 2 cultures of tubercle bacilli that could not be differentiated from bovine cultures. In Europe so many similar instances of bovine tubercle bacilli having been recovered from human tissues are on record that it appears entirely proved that man is susceptible to tuberculosis caused by animal infections, and while the proportion of such cases can not be decided with even approximate accuracy, it is nevertheless incumbent upon us to recommend such measures as will guard against these sources of danger.^a

MILK AS A CARRIER OF TUBERCULAR INFECTION.

The two principal sources of infection from cattle, and the only ones necessary to be considered, are the meat and the milk of tuberculous animals. The fact that most of the cases of bovine tuberculosis above enumerated which were found in the human occurred in infants points with grave suspicion to the milk rather than the meat supply. This naturally leads to the question of how and under what conditions does the milk become dangerous, since Bang, Rabino-witsch and Kempner, Ernst, Ravenel, Smith, MacWeeney, Moussu, Gehrman and Evans, Mohler, and many others have definitely determined the infectiveness of milk from tuberculous cows.

That milk coming from a tuberculous udder is capable of transmitting the infectious principle is conceded by all who have given the subject any consideration. It has been equally established that in advanced generalized tuberculosis the udder may eliminate tubercle bacilli without showing any indication of being affected. Careful experiments performed by trained and eminently responsible inves-

^a Ravenel has collected the number of cases of human tuberculosis which have been studied with special reference to the type of bacillus causing them, whether human or bovine, and states that of the 306 cases reported, 63, or approximately 20 per cent, were due to the bovine tubercle bacillus.

tigators have also demonstrated beyond reasonable doubt that tubercle bacilli at certain times may be present in the milk of cows which are affected with tuberculosis to such a degree that the disease can be detected only by the tuberculin test, so that in a herd of cows in the various stages of tuberculosis it is to be expected that some of them will secrete tuberculous milk, which, when mixed with other cows' milk, makes the entire product dangerous.

In this connection it may be stated that the market milk of the District of Columbia has recently been examined by the writer for the presence of tubercle bacilli by the intra-abdominal inoculation of guinea pigs, and in 2 samples, or 2.7 per cent of the 73 specimens tested, virulent tubercle bacilli were recovered.

The ease with which tubercle bacilli may be eliminated by the udder was strikingly illustrated by an experiment conducted by the British Royal Commission, in which a cow injected with human tubercle bacilli under the skin of the shoulder began excreting tubercle bacilli from the mammary gland seven days later, and continued to do so until its death from generalized tuberculosis thirty days after inoculation. Furthermore, Titze, of the Kaiserliche Gesundheitsamte, proved that human tubercle bacilli when injected into the jugular vein of milch cows may be excreted with the milk. In the first experiment the excretion of the bacilli began in the third week and continued until the one hundred and forty-fourth day. In a subsequent test tubercle bacilli began to be excreted after twenty-four hours, but no bacilli could be found after ninety-nine days. In both these cows only the milk from the left hind quarter proved to be infectious.

It has been shown by Gaffky and Eber in Germany and Schroeder in this country that, even when the tubercle bacilli are not being excreted by the udder, the dust and manure of the stable where the diseased animals are kept are in many cases contaminated with tubercle bacilli. This contaminated material may readily infect the milk during the process of milking, even though the milk comes from a healthy cow. The importance of this method of infecting milk can not be too greatly emphasized when it is known that cattle in prime condition, without any udder lesions but with alterations confined to the lungs, frequently raise tuberculous mucus into the pharynx while coughing, then swallow this material, and thus contaminate the feces. In a recent examination at the Bureau of Animal Industry Experiment Station of the manure passed by 12 cows just purchased from dairy farms supplying milk to the city of Washington and affected with tuberculosis to an extent demonstrable only by the tuberculin test, tubercle bacilli were found in over 41 per cent of the cases, by both microscopic examination and animal inoculations. The danger from this method of infecting milk is impressed upon us as consumers when we consider the prevalence of tuberculosis in dairy herds as disclosed by numerous tests.

PREVALENCE OF TUBERCULOSIS AMONG COWS SUPPLYING MILK TO
THE DISTRICT OF COLUMBIA.

Judging from the results of recent tuberculin tests, it is believed that on an average between 15 and 25 per cent of all the cows which supply milk to the District of Columbia are tuberculous. From April, 1907, to June 30, 1909, the Bureau of Animal Industry supervised the testing of 2,471 cattle in herds supplying milk to the District, with the result that on the first tests 377, or 15.25 per cent, were found tuberculous. Many other tests have been made by local veterinarians of which the bureau has no records. The percentage given is scarcely a fair estimate of the extent of tuberculosis in the dairy herds of this vicinity, since our tests include many herds which have either been cleaned previously by private tests or which have such a healthy appearance as to remove all suspicions of tuberculosis on a physical examination. Until November 26, 1909, these tests had all been voluntary on the part of the dairymen, and it is pleasing to note the large number who have had their herds cleaned of tuberculosis and the premises disinfected.

On the above date the Commissioners of the District of Columbia issued an order providing for the compulsory tuberculin testing of all cattle within the District, with the view to the suppression and prevention of this disease. As a result of this regulation practically all the cattle in the District have now been tested with tuberculin, and the results show that of the 1,701 cattle tested 321, or about 19 per cent, were tuberculous.

DANGER FROM TOXIN IN MILK OF TUBERCULOUS COWS.

Aside from the danger of tubercle bacilli in milk, some investigators (Le Blanc, Ripper, Jemma, and De Michele) consider the milk of tuberculous cows dangerous even when bacilli are not present, on account of the toxin it contains. Michellazzi has injected such milk into tuberculous animals and obtained a reaction.

ELIMINATE TUBERCULOUS CATTLE OR PASTEURIZE MILK.

To eliminate all tuberculous cattle from the herd or to pasteurize all milk coming from untested cattle should therefore be the object of all producers of milk, and sanitarians will be remiss in their whole duty should they neglect to guard against the products of tuberculous animals in their attempts to eradicate tuberculosis from man. This view was crystallized in a resolution adopted by the International Congress on Tuberculosis held at Washington in September, 1908, as follows:

Resolved, That preventive measures be continued against bovine tuberculosis, and that the possibility of the propagation of this infection to man be recognized.

TUBERCLE BACILLI IN OTHER DAIRY PRODUCTS.

Since milk is so often infected with tubercle bacilli, it is very evident that food products made from milk without submitting it to lethal temperatures during the process of their manufacture must frequently harbor virulent bacilli in undesirable numbers.

The investigations of Rabinowitsch, Klein, Laser, Bang, Petri, Dawson, Markl, Moller, and many others have conclusively shown that tubercle bacilli may be present in butter, buttermilk, margarin, and cheese when these products are offered for sale. Butter made in the customary manner and stored under the ordinary market conditions until time of sale, if dangerous through the presence of tubercle bacilli at the time of its manufacture, may retain its virulence through several months. This statement has been adequately proved by two series of experiments recently performed by the Bureau of Animal Industry.

In one series by Mohler, Washburn, and Rogers three samples of butter were tested. The first was made from milk to which bovine tubercle bacilli had been added just before churning. They were obtained from a luxuriantly growing culture upon glycerin bouillon. Ten centigrams were removed from the surface growth of the flask, carefully mixed in a sterilized solution, and added to 10 gallons of milk. The second sample was made from milk obtained from a cow affected with tuberculosis of the udder. In this milk tubercle bacilli of extreme virulence were present in great numbers. Both the first and second samples of butter were salted in the usual proportions of 1 ounce of salt to a pound of butter. The third sample was similar in every respect to the second, except that it was left unsalted. These samples of butter were tested upon guinea pigs, not only when first made, but also after storing for ten days in the ice chest, after holding in cold storage for sixty days, and again after retention in cold storage for a period of five months (one hundred and thirty-three days). The results showed that each of these samples harbored virulent tubercle bacilli throughout the entire storage period, and that at any time they were capable of infecting guinea pigs with tuberculosis if injected into the peritoneal cavity, and if the tuberculous butter was fed to the animals generalized cases of tuberculosis were still capable of being developed. In these experiments 10 guinea pigs were fed upon each butter sample for three consecutive days and 6 were inoculated with the same kind of material. Six weeks later they were chloroformed and the visceral organs of each were carefully scrutinized that every trace of tuberculosis might be detected. None of the lots of guinea pigs remained entirely free of tuberculosis, although those animals which were fed upon the contaminated butter failed to contract the disease as frequently as those

which were injected. This experiment is to be extended further in order to determine the maximum time in which infected butter, both salted and unsalted, will remain virulent when kept in cold storage under normal trade conditions. As the temperature in the cold-storage rooms is very low, the evidence shows that the tubercle bacilli are held unchanged in the frozen butter for a long period, but that they slowly lose their vitality.

In another series of experiments by Schroeder and Cotton, of the Experiment Station of the Bureau of Animal Industry, butter was made from the milk of a cow affected with udder tuberculosis. After salting at the rate of 1 ounce of salt to a pound of butter, the butter was kept without ice in a cellar at 60° F., and from time to time, up to one hundred and sixty days from the making of the butter, guinea pigs were inoculated with portions of the butter. More than 60 guinea pigs were thus inoculated and, with the exception of 5 that died prematurely and 1 that was killed, all died of generalized tuberculosis, and the one that was killed was also found affected.

In cheese, also, tubercle bacilli may become mixed up with the curd during the process of manufacture, and they have been shown to remain virulent for over three months. As a result of Galtier's experiments conducted with cheese, both salted and not salted, which was found to contain tubercle bacilli when 2 months and 10 days old, he concluded that coagulated milk, cheese, and salted cheese made from the milk of tuberculous cows may infect man, and that the by-products fed to swine and chickens may infect these animals. In experiments made in Switzerland to determine the fate of tubercle bacilli in cheese, it was demonstrated that they died between the thirty-third and fortieth day in cheese made after the Emmental method, but considerably later in cheese made approximately after the Cheddar method. An emulsion of tubercle bacilli was added to milk at the same time as the rennet, and cheese was made from the milk in the manner required to obtain Cheddar cheese. From the time of manufacture average samples of the cheese were taken weekly, macerated in sterile water, and filtered. Guinea pigs were inoculated with portions of the filtrate, and it was found that the germinating power of the tubercle bacilli lasted one hundred and four days, but after one hundred and eleven days they were incapable of conveying the disease to guinea pigs by inoculation. Harrison concluded that these experiments justify the statement that Emmental (or Swiss) cheese may be eaten with safety, as the period of ripening is much longer than the period during which the bacilli become innocuous. Cheddar cheese, he states, is seldom eaten under four months from time of manufacture, and during this period the tubercle bacilli lose their vitality. Notwithstanding this, however, Harrison recom-

mended the pasteurization of the milk in order to make the cheese absolutely safe. In a recent investigation conducted by the writer in cooperation with Doane, tubercle bacilli have been demonstrated by guinea pig inoculations in cheese one hundred and twenty-two days old, made after the Cheddar method.

In manufacturing margarin the method commonly employed is to subject the finely comminuted fat to a temperature not to exceed 50° C. for one and one-half hours. Sour milk is then added and the whole mass is thoroughly mixed; dairy butter is next added, and a certain proportion of oils (cotton, palm, cocoanut, etc.). Enough of one or more of these oils is added to lower the melting point to that of dairy butter. Hence it will be seen that artificial butter thus made may be infected in three ways: First, from the fat secured from the original cattle, as tubercle bacilli will withstand a temperature of 50° C. for some hours; second, from the butter or soured milk that has been added; and, third, from contamination during the course of its manufacture. Morganroth made examinations of 20 samples of oleomargarin, purchased in the open market, and proved the presence of virulent tubercle bacilli in 9 of the specimens.

Other products which occasionally are consumed by people, but are used more extensively as food for live stock, will also serve to convey tubercle bacilli from infected milk to those that are allowed to consume them. Thus whey from cheese factories and buttermilk and separated milk from public creameries are all offenders in this respect and have been incriminated, especially in the feeding of hogs and calves.

OTHER DISEASES AND CONDITIONS.

Foot-and-mouth disease, anthrax, cowpox, and rabies may be transmitted by the milk, and while no case of actinomycosis in man has been traced to the use of milk, it is desirable that the sale of milk from cows so affected should be prohibited, especially when the disease affects the udder. Such conditions as gastro-enteritis, milk sickness, and septic febrile conditions may render the milk injurious to the consumer. Local diseases of the udder, such as botryomycosis, mammitis, mastitis, etc., may render the milk unwholesome, especially when pus organisms are present. The color, taste, and odor of milk may be altered so as to make it unpalatable, if not unwholesome; these changes may be due to the food of the cow or to bacterial changes in the milk after it is drawn from the udder. Milk may acquire poisonous properties from the food eaten by the cow. The milk produced shortly before or during the first five days after parturition should not be used.

RECOMMENDATIONS.

In view of the facts above enumerated, the following recommendations are made as a basis for laws and for regulations by public-health officers:

1. That all cows on dairy farms producing milk for market purposes be tagged, tattooed, or otherwise marked for identification.

2. That all milk produced on such dairy farms shall either come from tuberculin-tested cattle, which shall be retested at least once a year, or be subjected to pasteurization under the supervision of the health authorities in case the herd is not tuberculin tested.

3. That no additions to any herd, whether the herd has been tested or not, shall be made in the future without subjecting the additional cattle to the tuberculin test.

4. That no license for the sale of milk shall in future be granted except to applicants having herds free of tuberculosis.

5. That the milk of cattle showing any of the udder affections above mentioned, or anthrax, rabies, gastro-enteritis, septic conditions, or clinical symptoms of tuberculosis, shall not be utilized as human food, even though the milk be pasteurized. Milk from cows fifteen days before and five days after parturition shall likewise be excluded.

6. That veterinary inspectors of the health department make frequent visits to dairies having untested herds, in order that they may discover all advanced cases of tuberculosis, or udder tuberculosis, as early as possible.

7. That the various States pass laws granting an appropriate indemnity to all owners of tuberculous cattle which come under their respective jurisdiction, the said animals to be slaughtered in abattoirs having federal or other efficient inspection.

III. THE RELATION OF THE TUBERCULOUS COW TO PUBLIC HEALTH.

By E. C. SCHROEDER, M. D. V.,

*Superintendent of Experiment Station, Bureau of Animal Industry,
United States Department of Agriculture.*

INTRODUCTION.

The International Congress on Tuberculosis at Washington in September, 1908, expressed the important conclusion, almost without a dissenting voice, that bovine tuberculosis, or tuberculosis among dairy cows, is a menace to public health of altogether too great importance to be ignored.

One result of Dr. Robert Koch's address at London in 1901, in which he announced his view that human and bovine tuberculosis are not identical diseases and that bovine tuberculosis is a negligible factor for the health of mankind, is the new life that was infused into investigations concerning all phases of the tuberculosis question. Everywhere investigators endeavored to prove or disprove Koch's announcement, and hence the conclusion of the international congress in 1908 has behind it the enormous mass of evidence collected during seven long years by diligent, scrupulous, impartial, and intelligent seekers for truth. It is not a hastily drawn conclusion or a conclusion based on inadequate evidence, neither is it the conclusion of a single man or of a few co-workers, but it is the nearly unanimous conclusion of those who are best qualified to weigh the evidence and to judge what it signifies, and hence it is the conclusion on the relationship of bovine tuberculosis to public health which, for the time being, we can not reasonably refuse to accept.

Though Koch reiterated his former view at the congress referred to, most of his arguments have fallen. For example, it has been shown that tuberculous lesions in persons, especially children, are frequently due to tubercle bacilli of the bovine type; that tubercle bacilli isolated from human tuberculous lesions may be more virulent for cattle than the bacilli commonly isolated from bovine tuberculous lesions; that tuberculosis of the organs of digestion and associated structures is much commoner than it was formerly believed to be; that the localization of tuberculous lesions in the lungs does not prove that the infection was inspired with the air; that the seat of tuberculosis in the body gives no clear idea of the portal through which the infecting organisms gained entrance; that tubercle bacilli may pass through the intestinal mucosa without affecting it and cause tuber-

culous processes in remote portions of the body, the lung and elsewhere; that the tuberculous processes in the lung commonly originate from the finer blood capillaries and not from the finer ramifications of the air channels, and consequently are attributable to tubercle bacilli that reached the lung with the blood stream; that the type of the tubercle bacillus, human or bovine, is not constant, and that the two types of bacilli, human and bovine, are connected by transition forms, so that one type merges gradually into the other.

As tuberculosis is alike the commonest disease of persons and cattle, and as persons and cattle are the commonest victims of tuberculosis, it is important for the protection of public health to know how tubercle bacilli are scattered from the bodies of tuberculous cattle and how they are introduced into the bodies of persons.

FACTS SHOWN BY EXPERIMENTS.

At the Experiment Station of the United States Bureau of Animal Industry the following facts were demonstrated:

1. The commonest way in which tubercle bacilli leave the bodies of tuberculous cattle is per rectum with the feces. Tuberculous cattle also expel tubercle bacilli from their mouths and nostrils, directly with their milk, and rarely with their urine. The tubercle bacilli expelled per rectum have their origin in most instances in the lung and throat, from which regions they are coughed up, swallowed, and passed through and out of the digestive canal without loss of pathogenic virulence.

2. The cattle that pass tubercle bacilli per rectum are not always visibly diseased; about 40 per cent of apparently healthy but tuberculous cattle, which are not known to be tuberculous until they are tested with tuberculin, intermittently pass tubercle bacilli from their bodies per rectum with the feces. This work of the Experiment Station has been confirmed by the work of the British Royal Commission on Human and Animal Tuberculosis. (See "Third Interim Report," London, 1909. A comparison of this report with Bulletin 99, May 11, 1907, and Circular 118, December 21, 1907, of the Bureau of Animal Industry, United States Department of Agriculture, is interesting.)

3. The commonest impurity in market milk is cattle feces. The amount of feces in market milk varies from a microscopic trace to a sediment clearly visible to the naked eye. Some samples of milk that show no sediment produce cream discolored precisely like the cream from milk heavily contaminated with feces; such milk must be regarded as exceptionally dangerous and dirty, but unusually well strained.

4. The union between cattle feces and the tubercle bacilli they may contain is not firm. The bacilli are evenly and loosely distributed throughout the entire mass of feces, from which, when they enter

milk, they become detached and float free. Guinea pigs inoculated with normal, fresh milk from healthy cows to which small amounts of feces from tuberculous cows were added contracted tuberculosis as readily when the milk was used in a strained as in an unstrained condition; hence tubercle bacilli introduced into milk with the feces of tuberculous cows can not be removed by straining.

5. When milk is allowed to stand for cream to rise, or when cream is separated from it rapidly in a centrifuge, the tubercle bacilli it may contain rise as abundantly with the cream globules as they gravitate with the sediment. This holds true when pure cultures of tubercle bacilli are added to milk, when the tubercle bacilli are added in the form of infected feces, when they are added in the form of pus from a tuberculous abscess, and when they are present because of a tuberculous condition of the udder. Hence cream from tuberculous milk, volume for volume, contains more tubercle bacilli than the milk. It must be clearly evident from this that no system of purifying milk from bacteria that depends upon gravity or centrifugal force is reliable.

6. Butter made from cream obtained from infected milk contains tubercle bacilli. This was proven by making butter from the milk of a cow affected with udder tuberculosis and by making it from the milk of a healthy cow to which small masses of feces from tuberculous cows had been added. The butter on inoculation into guinea pigs caused typical, generalized, fatal tuberculosis.

7. The bland, opaque character of butter, either salted or unsalted, forms an ideal environment for the preservation of the life and virulence of tubercle bacilli. Tubercle bacilli were found to show no appreciable attenuation in ordinary salted butter in forty-nine days, to be still highly virulent after ninety-nine days, not to have lost their pathogenic virulence after one hundred and thirty-three days, and to be capable of causing generalized fatal tuberculosis in guinea pigs after one hundred and sixty days.

As the investigation of the Experiment Station of the Bureau of Animal Industry to prove the long-retained virulence of tubercle bacilli in butter called out a public criticism to the effect that it was not fair to draw practical conclusions about the persistence of this virulence from the inoculation of guinea pigs, the following experiment, which may be more convincing, was made: Four healthy hogs, proven to be free from tuberculosis by the use of tuberculin, weighing 125 pounds each, in addition to their regular food were each fed 1 ounce of tuberculous butter daily for thirty days, or one month. Each hog thus received less than 2 pounds of butter during the month, or less than is usually eaten by persons of the same weight. The butter was made with cream obtained from milk naturally infected with tubercle bacilli, and every particle of this butter, which was

salted at the rate of 1 ounce of salt to the pound, was three months old or older at the time it was fed to the hogs. The hogs were kept under conditions under which no hog among the many used at the Experiment Station ever contracted tuberculosis from an accidental or unintentional cause. As the result of feeding the butter three of the four hogs became affected with typical tuberculosis.

More direct evidence that tuberculosis may be contracted through eating infected food, or more direct evidence to prove that tubercle bacilli may remain alive and virulent in ordinary salted butter for three months or a quarter of a year, would be difficult to obtain.

8. As has been shown by numerous other investigators, it was found, contrary to the length of time tubercle bacilli live in butter, that they die very rapidly on exposure to light and drying. Sunlight is so potent a factor in the sterilization of tubercle bacilli that it is doubtful whether a sticky tough substance like tuberculous sputum can reach a sufficiently fine state of pulverization to float in the air as a respirable dust without first losing its infectious character.

THE FREQUENCY OF TUBERCLE BACILLI IN MILK.

When we bear in mind that probably not less than 20 per cent of our American dairy cows are to some extent affected with tuberculosis (the percentage among the cows in European countries is much higher) and that fully 40 per cent of all tuberculous cattle, even when they retain the appearance of health, more or less intermittently expel tubercle bacilli from their bodies with the material (feces) that is the commonest, nearly a constant, impurity in milk, we can not fail to realize that tubercle bacilli must be of frequent occurrence in the milk currently sold for use as human food, and this is precisely what we find to be true when we turn our attention to an examination of market milk.

Numerous tests of milk purchased at Washington, D. C., showed that 1 among every 18 samples contained tubercle bacilli and that 1 among every 10 dealers intermittently sold infected milk, notwithstanding that the percentage of tuberculous cows among those from which the Washington milk supply is derived seems, from the tuberculin tests that have been made, to be comparatively low.

Few dairies distribute infected milk continuously. In most instances the distribution is intermittent. This seems to be a matter of some importance, because the extent to which public health is exposed to infected milk depends rather upon the number of dairies that distribute it than upon the percentage of milk samples found to be infected among a number examined, and because experience has shown that it is practically impossible, without an enormous amount of work, to prove definitely that any one dairy constantly sells or distributes milk wholly free from virulent tubercle bacilli. For example,

one test of the milk from a dairy at Washington showed it to contain tubercle bacilli. Some time afterwards samples of milk from this dairy were tested on each of thirty consecutive days. Among the 30 samples those of the second, third, and eighth days caused typical, fatal, generalized tuberculosis in guinea pigs, and those of the remaining twenty-seven days were found to be free from tubercle bacilli. Hence the fact that this dairy was intermittently distributing tuberculous milk would have escaped detection if as many as 22 samples of milk, taken on twenty-two consecutive days, beginning on the ninth day of the actual examinations, had been tested.

Professor Eber, of Leipzig, gives some figures which are interesting in connection with the intermittent distribution of infected milk by dairies. He tested the milk sold by 70 dealers on three different dates. On the first date 6 dealers, on the second 9, and on the third 7 were found to be selling tuberculous milk. The dealers who sold infected milk on the three dates are not always the same dealers, so that if we sum up the actual number who at one time or another sold tuberculous milk we have the number 19, and this is equivalent to the charge that three examinations of the milk sold by 70 dealers showed that 27.1 per cent, or more than one in four, from time to time sold tuberculous milk. Had Eber made a few more series of tests with the milk of the 70 dealers he probably would have found that even a larger percentage from time to time sold tuberculous milk.

The manner in which tubercle bacilli are expelled from the bodies of tuberculous cattle, frequently long before the remotest symptoms of disease are manifest, teaches that we can not hope to obtain milk from tuberculous cattle or from healthy cattle exposed in the environment of tuberculous cattle at all times free from tubercle bacilli; and the intermittent character of the distribution of tuberculous milk by dairies teaches that no milk is constantly safe unless it is obtained from cows that have been shown by the tuberculin test to be free from tuberculosis and that are milked, housed, fed, pastured, and in every way kept in an environment from which all tuberculous and all untested cattle are excluded.

PASTEURIZATION AS AN EXPEDIENT.

The amount of milk that can actually be produced under the conditions required to insure its freedom from tubercle bacilli must be, for some time to come, a relatively small proportion of the total supply, and therefore we are obliged to look for some expedient through the use of which milk when it is not produced under ideal conditions can be made a safe article of food. The least expensive and most efficient available expedient is pasteurization.

Pasteurization is a definite process, which must not be confounded in our minds with sterilization, scalding, boiling, etc. The proper

pasteurization of a delicate, unstable substance like milk, strictly speaking, signifies its exposure to a degree of temperature that will not markedly alter its character, for a sufficient period of time to kill nonsporulating disease germs. The minimum effective temperature is 60° C., and this should be maintained at least twenty minutes; the maximum temperature that does not cause objectionable modifications is 70° C., and this is sufficient to kill the disease germs of commoner occurrence in milk in ten minutes. The term "pasteurized milk" should be limited to milk which has been heated between 60° and 70° C. from ten to twenty minutes. Milk heated to a higher degree, or for a shorter period of time, should be defined by some other term. It seems very desirable that some authoritative body, conversant with the milk question, should write a clear definition of just what meaning is to be attached to the term "pasteurized" as applied to milk. Possibly it would be wise to drop the word "pasteurized" altogether, and to substitute some such term as "hygienically heated milk."

The fact that tubercle bacilli in milk rise as abundantly with the cream as they gravitate with the sediment, and the two facts that the bacilli in cream are transferred to the butter made from it and in butter find an ideal medium for the preservation of their life and virulence, teach that all cream should be obtained from the milk of cows certainly free from tuberculosis, or that it should be pasteurized or hygienically heated before it is used as food in the form of cream or for making butter. It has been conclusively shown that good butter can be made from pasteurized cream.

Though pasteurization is so strongly advocated, we should not lose sight of the fact that it is, after all, simply an expedient, and as such can not be used as a final solution of the milk problem. Above all it should not be used as an excuse for relaxing our efforts to secure milk that is perfectly safe without treatment of any kind, and its use to preserve dirty and otherwise unmarketable milk should under no circumstances be tolerated. That is to say, so long as the pasteurization of milk and cream is necessary as an expedient to protect public health, let us by all means practice it, but while practicing it let us continue to insist that established standards of purity shall be maintained and that these standards shall gradually be made higher and better.

SOME REASONS FOR GUARDING AGAINST INFECTED DAIRY PRODUCTS.

When we consider the sources from which the tubercle bacilli that make tuberculosis the commonest disease with which the human race is affected are derived, it is well to remember that tuberculosis has a unique place among pathological conditions. It is one of the

relatively small number of infectious diseases that attack more than one species of animals, and it is the only known infectious disease from which practically no vertebrate species is immune. It has received more attention from investigators in the realms of both human and veterinary pathology, bacteriology, and hygiene than any other disease, and yet our knowledge regarding it has remained in many respects exceedingly rudimentary. We know, for example, so little about its period of incubation that we can not say who is right, those who believe that tuberculosis arises from infection that may enter the body at any time of life, or those who believe that it almost constantly develops from latent tubercle bacilli taken into the body during the milk-drinking period.

We do know that tuberculous lesions of greater or lesser magnitude and varying stages of activity are found on autopsy with a frequency that prompts the conclusion that few persons wholly escape the tubercle bacillus. We know that tuberculosis is a disease that develops with a peculiar frequency during those periods of life when the drain on the mental and physical forces is greatest, rather than during periods following incidents of exceptional exposure to infection. We know that the children of tuberculous parents succumb to tuberculosis—not necessarily as children—more commonly than those of healthy parents; and we know that tuberculosis is not as common among those persons who have been unusually exposed to infection as we naturally have reason to expect it to be. Men with tuberculous wives and women with tuberculous husbands, when their family records are clean relative to tuberculosis, contract the disease so rarely that their presumably intense exposure can not certainly be said to infect them more frequently than persons in general become infected.

We know that tubercle bacilli are peculiar in that they may remain alive and virulent long periods of time in circumscribed closed tuberculous lesions, and we have reasons to believe that actually latent tubercle bacilli may remain in the body indefinite periods of time without causing conditions that can be identified as tuberculosis; and, finally, we know that sensibly active tuberculosis during child life is an extremely serious disease, and most apt to have a fatal termination.

Add to this that tubercle bacilli in dairy products are either in a fresh or in a well-preserved state; that their introduction into the body is direct and occurs with the use of indispensable articles of food; and that tubercle bacilli in sputum, which were long regarded as the commonest and most active cause for the propagation of tuberculosis, are exposed to conditions that almost certainly sterilize them before the sputum can be pulverized and float in the air; and we may

conclude that, whatever chances we, as adults, may be willing to take in the form of exposure to tubercle bacilli in milk and dairy products, we should not be derelict with the exposure of children. It is for the sake of children especially, the little beings whose welfare is a sacred obligation that stands second to nothing, that the fight for pure milk should be made so strong that it will overwhelm every opposition.

INTERPRETATION OF RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF MILK.

By **L. A. ROGERS** and **S. H. AYERS**,
*Bacteriologists, Dairy Division, Bureau of Animal Industry,
United States Department of Agriculture.*

OBJECTS OF BACTERIOLOGICAL EXAMINATIONS.

The bacteriological examination of milk may be made to detect the presence of pathogenic bacteria, or its purpose may be the determination of the number and kinds of bacteria in general which the milk contains.

It is difficult to demonstrate the presence of disease-producing bacteria in milk, and the results of an examination are so uncertain that it is rarely undertaken. The bacillus of tuberculosis may be found by special microscopic methods or its presence detected by animal inoculation but these methods can not be applied to diphtheria, typhoid fever, and other diseases transmitted through milk. The usual bacteriological examination of milk is concerned not with this class of bacteria but with the second of the above mentioned objects, which is to obtain an indication of the manner in which the milk has been collected and transported, since it is now well established that there is a direct relation between the degree of cleanliness with which milk is produced and the number and kinds of bacteria which it contains.

SOURCES AND CLASSES OF BACTERIA IN MILK.

It will be necessary before considering the interpretation of bacteriological results to discuss briefly the more important sources of bacteria in milk and the methods by which they are counted.

Milk as it comes from the udder contains bacteria; the number varies with different animals, but usually so small that it is unimportant except in dairies which undertake to produce milk with a very low bacteriological count. Most of the bacteria occurring in the udder belong to a species having little effect on milk and are easily recognized by their morphology and peculiar colonies.

The bacteria which subsequently find their way into the milk may be roughly divided into three general classes: (1) Acid-forming bacteria, (2) liquefying or digesting bacteria, and (3) bacteria which render milk alkaline or produce no apparent change.

The acid-forming group includes the true lactic-acid bacteria, which are widely disseminated and are carried into the milk from

stable dust, feces, and other dirt, and the gas and acid-forming bacteria of the coli communis and aerogenes type, which are for the most part of distinctly fecal origin.

The term "liquefiers" or "digesters" is used to designate a great variety of bacteria having little in common save the ability to excrete proteolytic enzymes which are made evident by the liquefaction of gelatin or the digestion of casein. Some of these are also acid formers, and probably come from the skin of the animal. Others are found in large numbers in the feces. These bacteria also are carried into the milk in the dust of the stable, the water or mud in which cows wade, and the dirt falling from their udders and flanks.

The third group includes all bacteria not embraced by the first two groups and covers a great variety of organisms. They are usually looked upon as having little effect on milk, and consequently as having no especial significance in bacteriological counts. It is not improbable that more careful study of some of these bacteria will show that they have a decided influence on the quality of the milk in which they are present.

SIGNIFICANCE OF NUMBERS AND METHODS.

Bacteriological examination may be made merely to determine the total bacteria without regard to the kinds present. This is of value and under many circumstances is the only determination that can be made. Numerical bacteriological standards which are unquestionably of value are necessarily arbitrary and are based on the count of total bacteria only.

Special methods are necessary to obtain any insight into the relative numbers of bacteria of the different groups occurring in milk and by the information thus obtained to form an opinion regarding the cleanliness and care observed in producing and marketing the milk. It is obvious that the correctness of the deductions depends in a large measure on the exactness with which bacteriological results can be obtained. It is not only desirable that uniform methods and media be used in different laboratories in order that results may be comparable, but it is equally important that these methods be so carefully adjusted that they do not give a distorted picture of the bacterial flora of the sample.

INFLUENCE OF REACTION OF MEDIA ON COUNTS.

The accuracy of bacteriological counts depends most of all on the composition and reaction of the media and the time and temperature of incubation of the plates. The number obtained with one set of conditions may be the maximum for the particular sample under examination, but the same conditions would not necessarily give a maximum count for another sample, nor would the error be constant,

because the relative number of bacteria of different groups is subject to great variation. This is illustrated in Tables 1 and 2, which give the results of counts made with media of varying reactions. The highest count was obtained with the medium having a reaction of +1.3, and in computing these tables it is assumed that this count was 100 per cent of the bacteria present.

TABLE 1.—*Relative numbers of bacteria obtained with media of different reactions.*

Reaction of media.	0 days.	1 day.	2 days.	3 days.	5 days.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
+0.15.....	3.92	1.29	2.46	0.11	0.45
+0.8.....	76.33	68.49	77.51	81.96	50.76
+1.3.....	100.00	100.00	100.00	100.00	100.00
Relative numbers of different groups:					
Peptonizers.....	7.1	11.1	23.8	10.2	36.3
Acid.....	3.5	7.4	0	8.1	27.2
Alkaline or inert.....	89.2	81.4	76.1	81.6	36.3

The counts to show the influence of reaction of the media were made on litmus lactose agar. The relative number of the different groups was determined by litmus lactose gelatin having a reaction of +1. On the initial count given in Table 1 the medium with a reaction of +0.8 gave 76.33 per cent of the total, while that with a nearly neutral reaction gave only 3.92 per cent of the total bacteria. This ratio changed as the proportion of lactic-acid bacteria increased, and on the fifth day, when this group had increased from 3.5 to 27.2 per cent of the total, the medium with a reaction of +0.8 gave only 50.76 per cent of the total bacteria. This variation is greater in Table 2, which shows counts made under similar conditions on the same sample of milk but in which the proportion of lactic-acid bacteria had been artificially increased.

TABLE 2.—*Relative numbers of bacteria obtained with media of different reactions, the proportion of lactic-acid bacteria having been artificially increased.*

Reaction of media.	0 days.	1 day.	2 days.	3 days.	5 days.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
+0.15.....	1.04	0.86	8.06	1.53	0.31
+0.8.....	42.91	19.88	46.51	45.45	20.12
+1.3.....	100.00	100.00	100.00	100.00	100.00
Relative numbers of different groups:					
Peptonizers.....	13.6	3.9	8.4	5.6	1.7
Acid.....	25.0	71.4	41.3	57.9	79.0
Alkaline or inert.....	61.3	24.6	50.1	36.4	19.1

On the initial count 25 per cent of the bacteria in the milk were acid formers, and the media with reaction of +0.8 gave 42.91 per cent of the total. After 5 days the acid formers had increased to 79 per cent and the count on the +0.8 media dropped to 20.12 per cent of the total. In this connection the possibility that rapidly-growing

forms may change the reaction of the media and prevent the development of colonies of other bacteria should be considered. Discrepancies in results may frequently be accounted for in this way.

INFLUENCE OF TEMPERATURE OF INCUBATION.

The influence of the temperature of incubation on the count is well known. More accurate results can be obtained by incubating for four or five days at low temperatures, but in inspection work it is frequently necessary to incubate the plates at temperatures high enough to produce a quick development of colonies. Accuracy in differential counts can be obtained only by incubating at low temperatures and allowing sufficient time for the slow-growing colonies to develop their characteristics.

INFLUENCE OF AGE AND TEMPERATURE OF MILK.

A count of the total bacteria does not always give a true indication of the conditions under which the milk is produced. In order to interpret results intelligently it is necessary to know if possible the age of the milk and the temperature at which it has been held. Clean milk which has been held several hours in a warm place may contain more bacteria than dirty milk when fresh or even after two or three days if it has been held at a low temperature. This is shown in Table 3. Samples 1 and 2 were evidently produced under fairly sanitary conditions, while No. 3 was poor milk. Nos. 2 and 3 were held at 10° C. (50° F.) and No. 1 at 20° C. (68° F.).

TABLE 3.—*Influence of temperature on relative numbers of bacteria in clean and dirty milk.*

No.	Condition.	Temperature.	Initial number of bacteria.				Number after 24 hours.			
			Total.	Peptonizers.	Acid.	Alkaline or inert.	Total.	Peptonizers.	Acid.	Alkaline or inert.
1	Good.....	68° F.	39,000	5,000	10,000	24,000	106,000,000	26,000,000	24,000,000	56,000,000
2	Good.....	50°	43,400	10,000	13,900	19,500	660,000	50,000	280,000	330,000
3	Poor.....	50°	13,900,000	1,500,000	10,900,000	1,500,000	85,000,000	1,000,000	68,000,000	16,000,000

The initial count of sample 1 indicated the conditions under which it was produced, but after twenty-four hours it contained more bacteria than No. 3 when fresh or even when twenty-four hours old. If No. 1 had been held at the same temperature as No. 3, it would in all probability have given a count corresponding to that of sample 2.

If the history of the sample is not known, some conception of the conditions under which the milk has been produced and held may be obtained by determining the relative numbers of bacteria of the important groups. When sample 1 was twenty-four hours old the

acid-forming bacteria amounted to only 21 per cent of the total, while the count for sample 3 showed 78 per cent of acid formers when fresh and 80 per cent when twenty-four hours old. It is probable that this ratio is reasonably constant and can be used as an evidence of age and the care taken of the milk, but this can be demonstrated only by the collection of a large amount of data.

SIGNIFICANCE OF GAS-FORMING BACTERIA.

Some board of health laboratories in their supervision of the milk supply make routine examinations for gas-forming bacteria, which are considered by many authorities a good indication of the past history of the milk.

A large portion of the gas-forming bacteria probably find their way into milk directly from cow feces by unclean methods of milking. They may be introduced by particles of manure which fall directly into the milk from the body of the cow or from the dust of the stable. In some Middle Western States organisms of the colon-aerogenes group occur commonly on grass, grain, and in slough holes, therefore the gas formers in milk from cows milked in open fields may not come from a fecal source. In exceptional cases the milk may be contaminated by polluted water, which is sometimes added directly to the milk, but more often gains access by careless methods of cooling in which cans of milk are placed in well water.

The gas-forming bacteria are determined by special methods, which may be easily applied in any bacteriological laboratory. In laboratories where such tests are made the presence of the colon-aerogenes group is almost always demonstrable in commercial market milk.

Routine examination for *Bacillus coli* in Baltimore has shown its presence in 0.001 of a cubic centimeter of milk in 25 per cent of the samples in winter and 75 per cent in summer.

In interpreting the results of bacteriological examinations for gas-forming bacteria the effect of the temperature at which the milk is held must be taken into consideration. A high temperature distinctly favors the growth of gas formers, and if in warm weather commercial milk is allowed to stand without being iced the souring is often found to be due to the gas formers. Milk which in transit has been allowed to stand on a depot platform in the hot sun before it is placed in refrigerator cars may upon examination by special tests show high numbers of gas-forming bacteria. If the same milk had been held at low temperatures the same tests might have been negative.

The determination of gas-forming bacteria in milk does undoubtedly give additional evidence as to the sanitary quality of a milk.

In the Eastern States it shows evidence of contamination by cow feces and in special cases may show contamination by polluted water. In the Middle Western States the more common distribution of the colon-aerogenes group renders the test less accurate as an indication of pollution by manure. In any case, however, gas-forming bacteria in milk may be said to indicate careless methods either at the time of milking or in the subsequent handling.

At present it is impossible to set any standard for the number of gas-forming bacteria which may be allowed in a clean milk. It may be said, however, that a clean milk should give negative tests in the majority of cases when 10 cubic centimeters of milk are used.

SIGNIFICANCE OF LEUCOCYTES AND STREPTOCOCCI.

Some authorities consider the presence in milk of leucocytes or streptococci of importance as indicating a disordered condition of the udder of one or more of the cows supplying the milk. In a few cities the sale of milk is prohibited when microscopical examination reveals the presence of cocci in chains or leucocytes in excess of an arbitrary standard.

The occurrence of mastitis or similar pathological conditions of the udder results in the throwing off with the milk of an increased number of leucocytes. These are usually accompanied by pus-forming bacteria, which are easily recognized under the microscope by their morphology and their tendency to chain formation. Recent work has shown, however, that leucocytes or similar cells are always given off with the milk and that their presence does not necessarily mean that the cow is unhealthy in any way. The number occurring in the milk varies greatly even among healthy animals, and although the number found in the milk from a normal udder is almost always less than in that from an affected udder, this does not always hold, and any fixed leucocyte standard would sometimes exclude the milk of healthy animals. Moreover, the methods usually employed to estimate the number of leucocytes in milk are admittedly inaccurate and the results are subject to great variation due to imperfect technique.

A somewhat similar objection may be made to the streptococcus determination, which is based on the assumption that chain formation is peculiar to the pathogenic varieties of the streptococci. The pus-forming cocci compose one branch of a large bacterial family, which includes the ordinary lactic-acid bacteria. The difference between the various branches is usually slight and may be regarded as the assumption of some particular function in addition to those possessed in common by the entire family. Thus the essential difference between the pathogenic streptococci and some of the non-

pathogenic lactic-acid bacteria probably lies only in the ability to produce pathological conditions in the animal organism. How slight this difference is may be seen in the readiness with which the pathogenic function may be lost on the one hand or acquired on the other. The tendency to form long chains is not a peculiarity of any one branch of the streptococcus group. It may be found more uniformly among the pus-forming cocci, but is not infrequently observed in harmless cultures. However, the streptococci producing pathological conditions in the udder may cause gastro-intestinal disturbance or throat troubles in man, and several epidemics of this nature have been traced to diseased cows from which the contagion has been spread through the milk.

The presence of streptococci or unusual numbers of leucocytes in stained preparations of milk has been used successfully in detecting affected animals. The affection in the udder may be detected before the trouble has developed sufficiently to make it noticeable in an ordinary clinical examination. The value of the leucocyte and streptococcus examination can not be questioned, provided it is used as a basis for a more extended investigation. The error lies in the attempt to establish an arbitrary standard not warranted by our present knowledge and technique, and the condemnation of all milk which fails to conform to this test.

V. PASTEURIZATION, ITS ADVANTAGES AND DISADVANTAGES.

By M. J. ROSENAU, M. D.,

Professor of Hygiene and Preventive Medicine, Harvard Medical School; formerly Director of the Hygienic Laboratory, United States Public Health and Marine-Hospital Service.

The writer, in Hygienic Laboratory Bulletin 41, discusses the technical and practical side of pasteurization of milk, and recognizes that a pure milk is better than a purified milk. However, it is so difficult to obtain clean fresh milk in a large city that it is necessary to destroy the danger which so frequently lurks in raw milk.

Pasteurization is a cheap and efficient method of accomplishing this result. It has a few disadvantages which must be considered; but the fact that it saves many lives and prevents much sickness far outweighs the disadvantages, many of which are theoretical.

Pasteurization as applied to milk consists in heating it to 60° C. for twenty minutes, followed by rapid cooling. The degree of heat and time of exposure, as well as the day on which the milk was heated, should be stated in each case. In practice it is perhaps well to require either a slightly higher temperature or a little longer time than 60° C. for twenty minutes in order to provide the factor of safety necessary in large commercial operations.

There can be no more objection to the heating of milk for adults and children over three years of age than there is to the cooking of beefsteak. The simple expedient of pasteurization (which at best is only an expedient) would prevent many a case of typhoid, diphtheria, scarlet fever, Malta fever, tuberculosis, and children's summer complaint, etc.

The writer, in all his writings upon the subject of milk hygiene and pasteurization, insists upon obtaining, so far as possible, milk from healthy cows in a cleanly manner and protected against pollution and infection. This desideratum can largely be accomplished through education of the farmer, transportation agents, and dairy-men, all of whom should be under strict and energetic official supervision. Inspection and education, therefore, will accomplish much; but in the present state of the milk industry it can not protect against infection. The milk problem of a large community is precisely similar to the water problem. Sanitarians have now come to the sensible conclusion that the watershed should be protected, but nevertheless the water must be purified by filtration. Similarly the

"milkshed" should be protected, but the milk can not be depended upon unless it is pasteurized.

The objections to the use of pasteurized milk, even for infant use, are gradually disappearing. It appears that pasteurization is the inevitable outcome of the future, for it will soon be generally recognized that raw milk is apt to be dangerous milk and that heated milk is the only safe milk and will remain the only safe milk for the use of mankind.

Pasteurization saves lives and prevents sickness. Weighing against this great merit we have certain disadvantages connected with the heating of milk. That there are two sides to the question may be judged from the fact that those who have given the matter careful consideration come to diametrically opposite conclusions. From a theoretical standpoint some believe pasteurization to be an unsatisfactory and very feeble way out of a very difficult situation. From a practical standpoint, others find in pasteurization our only practicable safeguard, at least until the general supply consists of good, clean, fresh milk.

One of the chief objections to pasteurization is that it promotes carelessness and discourages the efforts to produce clean milk. It is believed that the general adoption of pasteurization will set back improvements at the source of supply and encourage dirty habits. It will cause the farmers and those who handle the milk to believe that it is unnecessary to be quite so particular, as the dirt that gets into the milk is going to be cooked and made harmless. It is not proposed that pasteurization shall take the place of inspection and improvements in dairy methods. To insure the public a pure and safe milk supply should be regarded as one of the most important duties of the health officer. Whether pasteurization is adopted by a city for its general milk supply or not, no milk should be accepted that does not comply with certain reasonable chemical and bacteriological standards. This would aid the inspectors in enforcing good dairy methods. Pasteurization then must not be used as an excuse to bolster up milk unfit for home consumption. To insure this end, the health officer should have authority to condemn and destroy bad milk, whether or not pasteurization is practiced.

To obtain a good milk supply involves not only an expensive system of inspection and surveillance from the farm to the consumer but intelligence and a high degree of technical skill on the part of the producer and all others who handle the milk.

We can scarcely conceive of an inspection so thorough and constant as to prevent milk occasionally becoming contaminated with the germs of typhoid, diphtheria, scarlet fever, dysentery, tuberculosis, etc.

If our drinking water is defiled at its source we boil or filter it. It would be much better to prevent its contamination. The same is

true of milk. We prefer pure milk, but so long as we can not obtain it we must purify what we get. The situation may well be illustrated by the attitude of an eminent sanitarian in New York who in his writing and public addresses discourages pasteurization because theoretically it does not reach the source of the evil and is not as good in the end as purification of the milk supply through efficient inspection. However, when this same sanitarian is consulted by a large wholesale dealer of New York, who handles many thousands of quarts of more or less old dirty milk a day, he is confronted by a condition, not a theory, and advises pasteurization.

There is a prevalent impression that the pasteurization of milk improves that important article of diet. Heating does not render milk better in any way as a food. All it does is to destroy certain bacteria and some of their toxic products. It checks certain processes of fermentation and putrefaction, thus rendering the milk safer. On the other hand, the evidence seems clear that the pasteurization of milk at 60° C. for twenty minutes does not appreciably deteriorate its quality or lessen its food value.

Pasteurization has been accused of possessing the great disadvantage of inducing scurvy and rickets. It is generally believed that highly-heated milk is a contributive factor in the etiology of scurvy. There is certainly no evidence to show that low-temperature pasteurization such as is now recommended ever in itself induces scurvy. Thousands of children have been raised upon heated milk without the production of this disease, which is comparatively rare, especially in countries such as Germany and France, where the artificial feeding with heated milk is most popular. Scurvy is preventable and amenable to treatment. Rickets result from defective alimentation and improper hygiene and can not be laid at the door of pasteurization.

Comparative observations upon infants under the same conditions show that they flourish quite as well upon heated milk as upon raw milk. Laboratory experiments as well as clinical observations coincide with the view that heated milk is quite as digestible as raw milk. In fact, it is now claimed to be more so. Metabolism experiments indicate that the utilization of calcium and iron in the body is more complete in children fed upon boiled cow's milk than in those fed upon raw cow's milk.

One of the great objections to the pasteurization of milk is that it devitalizes it. If milk contains "life" it has probably lost the last vestige of it after it is from twenty-four to forty-eight hours old and kept under such conditions that it contains myriads of bacteria. It has been shown that heating milk to 60° C. for twenty minutes, while it kills the pathogenic organisms, does not seriously affect the enzymes and the enzymes are the nearest approach to "life" with which we are familiar in milk. The germicidal properties of milk are not seriously injured at 60° C.

Another objection frequently urged against pasteurization is that some of the bacterial toxins are not killed at the ordinary temperatures used. We do not even know the nature of these poisonous products in milk, much less their thermal death points. The true bacterial toxins are destroyed by heating to a temperature of 60° C. for twenty minutes. It must be remembered that if milk contains bacterial toxins not destroyed by pasteurization it will contain these same poisons if the milk is consumed raw. In fact the heating of the milk prevents the further formation of such injurious substances.

Pasteurization, it has been claimed, results in the destruction of the ordinary acid-producing bacteria, nature's danger signal of old milk. The heating interferes with the souring process, so that fermentation of another and perhaps more serious nature may take place without the knowledge of the consumer. It has been shown that certain resistant spore-bearing bacteria have the property of peptonizing the albumens in milk. These bacteria survive the process of pasteurization, and are thus given a free field for growth, whereas in the raw milk these bacteria are largely held in check by the growth of the lactic-acid-forming organisms. This view started with the work of Flügge and has gradually lost ground for lack of clinical and laboratory confirmation. For instance, Park and Holt found that a few cases of acute indigestion immediately followed the use of pasteurized milk more than thirty-six hours old. Samples of such milk were found to contain more than 100,000,000 bacteria per cubic centimeter, mostly spore-bearing varieties. The deleterious effects, though striking, were not serious or lasting. However, so long as the danger is suspected, it makes us cautious to keep pasteurized milk cold and use it promptly.

We are told that heating destroys great numbers of bacteria in milk, and thus conceals dirt, but Theobald Smith ^a points out—

that from a bacteriological standpoint the pasteurization of milk will not conceal dirt, for the reason that the bacteria that come from the udder or the teats will be destroyed, but the bacteria that come from dirt are largely spore-bearing bacteria and these survive. I believe that we could control the quality of milk quite as well after it was pasteurized by bacteriological counts as before, because certain species only would grow or multiply and the indicators would be much better than to-day. If we examine a plate made from milk, for instance, nobody can tell exactly whether the bacteria are due to dirt or whether they are due to the multiplication of ordinary lactic acid bacteria, unless a very careful study of that plate be made. As a rule, if nearly all the colonies are alike, we say that they are the result of multiplication; if they are quite different then there has been a good deal of dirt added to the milk. Now, it seems to me that with pasteurization it would be possible to control the dirt in milk much better than is done to-day.

^a Smith, Theobald. *American Journal of Public Health and Journal of Massachusetts Association of Boards of Health*, vol. 17, 1907, p. 200.

Further, it is said that we must not meddle with nature; that pasteurization is an artificial expedient. Nature never intended milk to be collected, transported, and fed to young mammalian animals one or two days after it leaves the mammary gland. Even when fresh, the milk of one species is not well suited to the needs of the young of another species. In the artificial feeding of infants with cow's milk, we are meddling with nature. When artificial feeding is necessary we must endeavor to obtain fresh, pure milk. If this is not possible the milk should be purified, especially in the hot weather. Each infant is a law unto itself.

Pasteurization of all of the milk supply of a community may not be desirable. The clean, fresh milk, free from contamination, may not need it. Special cases may require raw milk, but the general public should be protected against the old, dirty, and uncared for milk which forms the bulk of the supply of large cities.

The heating must be done intelligently and under the supervision of the health officer. After heating, the milk is just as liable to serious contamination as before if not more so. It must therefore be carefully guarded, kept cool, and promptly delivered.

Theobald Smith,^a 1907, expressed the opinion that pasteurization is the inevitable outcome of the future. He says:

It seems to me that the real difficulty of the present condition is the transmission of specific disease germs which are not easily controlled by any amount of cleanliness, and these specific disease germs, one and all of them, may be destroyed by the average pasteurization.

Sedgwick^b voices the opinion of many sanitarians when he states that—

when all is said and done, I agree with Professor Smith that we have got to pasteurize milk. Cooked milk is the only safe and always will remain the only safe milk for the use of mankind. Little by little the idea is spreading that raw milk is apt to be dangerous milk.

Theoretically, pasteurization should not be necessary; practically, we find it forced upon us. The heating of milk has certain disadvantages which must be given consideration, but it effectually prevents much disease and death, especially in infants during the summer months.

^a Smith, Theobald. Discussion of Rotch's paper on "The pasteurization of milk for public sale." *American Journal of Public Hygiene*, vol. 17, May, 1907, p. 200.

^b Sedgwick, W. T. Discussion of Harrington's paper on "Some of the ways in which infection is disseminated." *Journal of Massachusetts Association of Boards of Health*, vol. 14, Feb., 1904, p. 41.

636.073
25-8

8950 U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 154.
A. D. MELVIN, CHIEF OF BUREAU.

THE NEED OF STATE AND MUNICIPAL MEAT INSPECTION TO SUPPLEMENT FEDERAL INSPECTION.^a

By A. M. FARRINGTON, D. V. M.,
Assistant Chief, Bureau of Animal Industry.

To provide clean, healthful, wholesome meats for rich and poor alike is one of the problems of modern civilization. In the early days, when people lived in rural communities, each householder killed animals of his own raising to supply meats for his own family and for his neighbors. In these days, when people are massed in large towns and cities, it is not possible for each individual to know from personal observation the source of his meat supply and whether or not it comes from healthy animals.

The purchaser at the retail store or market can determine whether the meat is satisfactory in appearance, price, and cut, but its source and previous treatment are practically a sealed book and positively unknown to the majority of people.

BRIEF OUTLINE OF MEAT INSPECTION IN THE UNITED STATES.

The first effort to solve the problem of a healthful meat supply for the people of the United States was begun by the Federal Government in the meat-inspection act of March 3, 1891.^b This act was not adequate for the purpose, in that it did not give sufficient authority to supervise all the processes to which meat is subjected. It enabled the Department of Agriculture to certify that the meat of animals at the time of slaughter was free from disease, but it gave no power to follow the meat through the different processes of curing, pickling, smoking, etc., in the packing house, nor did it give authority to supervise the sanitary condition of the rooms or buildings where the meat was handled. This lack of authority has now been remedied by the Federal meat-inspection act of June 30, 1906. By this act the extent of the meat inspection conducted by the Government has been greatly increased and enlarged.

During the fiscal year ending June 30, 1906, the meat inspection under the several previous acts had been conducted at 163 establish-

^a This article is based on a paper presented at the Twelfth Annual Convention of the Association of State and National Food and Dairy Departments, at Mackinac, Mich., August 4, 1908, and reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry (1908).

^b The act of August 30, 1890, provided for the inspection of meat for export only, and was a commercial rather than a sanitary measure.

ments in 58 cities and towns. In the fiscal year ending June 30, 1907, such inspection had been conducted at 708 establishments in 186 cities and towns, while the number of employees required to put in force the provisions of the new act was 2,290 as against 981 under the former act. There was a proportionate increase in the amount of money spent, \$2,159,474 being the amount expended for the fiscal year 1907 as against \$771,661 for the previous year. The act of June 30, 1906, makes a permanent annual appropriation of \$3,000,000 for meat inspection.

With the authority of this law the Secretary of Agriculture may cause to be made by inspectors, appointed by him for that purpose, an examination and inspection of all live cattle, sheep, swine, and goats before they are allowed to enter any slaughtering, packing, meat-canning, rendering, or other similar establishment where meat or meat food products are prepared for interstate or foreign commerce. He is also required to cause to be made by inspectors, appointed by him for that purpose, a post-mortem examination and inspection of the carcasses and parts thereof of all such animals to be prepared for human consumption at any such establishment for transportation or sale as articles of interstate or foreign commerce. The act makes an exception in the case of animals slaughtered by farmers on the farm and by retail butchers and retail dealers supplying their customers.

The law is very explicit and describes in more or less detail how the inspection shall be conducted. It provides for the issuance of regulations which prescribe the manner of making the inspection. Any person engaged in the slaughtering, packing, canning, or rendering of meat food products for interstate or foreign trade must make application for inspection to the Secretary of Agriculture, on blanks furnished for that purpose, stating the number and kind of animals slaughtered or animal products handled, the amount prepared for local consumption, and the amount prepared for interstate or foreign trade, the applicant agreeing to conform to all lawful rules and regulations. On receipt of this application it is sent to the Chief of the Bureau of Animal Industry, who designates an inspector to visit the establishment and report upon its sanitary condition and its facilities for inspection. If alterations are required in order to conform to the regulations the proprietor is notified in writing, and inspection is not commenced until these changes are made or positive assurances given that the plant will be put in a satisfactory condition.

When these preliminary matters are arranged the necessary force of inspectors is detailed for the inspection. A veterinary inspector is assigned to take charge if the establishment is engaged in the slaughter of animals, and he is furnished with a sufficient number of

assistants to supervise the work according to the regulations. The veterinary inspectors personally conduct the post-mortem inspection of all animals slaughtered. All carcasses which come from healthy animals are marked by a metal or rubber stamp and purple ink with the legend "U. S. Inspected and Passed" and the official number of the establishment.

By selecting meat that bears this stamp consumers are assured that it came from animals found healthy on post-mortem examination. The Federal inspection, however, is limited to establishments that are engaged principally in supplying meat for the interstate or foreign trade. Although some of this meat is no doubt sold for local consumption, a great quantity is put upon sale that does not receive such inspection.

EXTENT OF SLAUGHTER WITHOUT GOVERNMENT INSPECTION.

It will be interesting at this point to inquire into the number of animals that are killed to be consumed within a State. The slaughter of food animals in the United States may be divided into three classes, as follows:

(1) The wholesale and packing, (2) the slaughter by small butchers, and (3) the farm slaughter. The Bureau of the Census has published figures relating to the first and third classes, but not the second, and those relating to the third are somewhat out of date, as they last appeared in the Eleventh Census (1890).

The general public is intimately concerned with the first two classes, as both of them enter into trade. While the wholesale and packing class is wholly included in the Government inspection, such is not the case with class 2 (small-butcher slaughter). It is, therefore, desirable to ascertain the extent of the latter, so as to determine to what degree the people are dependent upon State and municipal inspection for the wholesomeness of their meat products. Although exact figures can not be given, enough can be shown to indicate that the number of animals annually slaughtered by local butchers is probably very much larger than is generally supposed.

The method adopted to find the required number for the year 1907 is based, first, on the numbers of domestic animals in the country on January 1, 1907, as estimated by the Bureau of Statistics, Department of Agriculture; and, second, on the application to these numbers of certain percentages, representing the total annual kill of each species. The percentages referred to have been previously ascertained and published by the Bureau of Animal Industry in the Twenty-second Annual Report, and may be applied to any normal year of live-stock production.

Having thus obtained an estimate of the total number of the various animals disposed of in 1907, it simply remains to deduct (1) the

number slaughtered under Federal supervision, (2) the estimated farm slaughter, and (3) the number exported from the country alive. After these deductions there is left a remainder which necessarily represents the small-butcher slaughter, the whole of which is without Federal inspection.

The totals of these various items are given in the statement below :

Estimated number of cattle, sheep, and swine in United States, and number slaughtered, with and without Federal inspection, etc., during 1907.

Item.	Cattle.	Sheep.	Swine.
Number in United States January 1, 1907 (as estimated by Bureau of Statistics, Department of Agriculture)	72,534,000	53,240,000	54,794,000
Estimated total number disposed of in 1907	14,507,000	19,166,400	59,725,460
Slaughtered under Federal supervision	7,633,365	10,252,070	32,885,377
Estimated farm slaughter	1,500,000	1,000,000	16,500,000
Exported alive	401,583	121,197	23,783
Remainder—slaughtered by butchers without Federal inspection....	4,972,032	7,793,133	10,316,300

* Percentages applied : Cattle, 20 per cent ; sheep, 36 per cent ; swine, 109 per cent.

NOTE.—In addition to the above, there were 2,024,387 calves slaughtered under Government supervision, and probably fully as many without Government inspection.

It is seen from the foregoing that practically 5,000,000 cattle, nearly 8,000,000 sheep, and over 10,000,000 hogs were slaughtered by butchers in 1907 without Federal inspection, to which may be added about 3,000,000 calves. All these 26,000,000 animals were consumed by the people of the United States, and the responsibility of inspecting them has rested wholly upon the State and local authorities, since they are beyond the reach of the Federal inspectors.

LOCAL SLAUGHTERHOUSES AND THEIR EVILS.

The slaughterhouses where animals are killed for local consumption are usually isolated and scattered about the city or town, either situated on some back street, surrounded by stables and dwelling houses, or outside of the corporate limits, each butcher apparently trying to avoid observation. In many instances the houses are located on the banks of streams or creeks, and the drainage is toward such streams. Frequently the offal is thrown on the banks to decay or to be devoured by hogs or rats.

Such houses, in addition to being unsightly, malodorous, unclean, and insanitary in the extreme, are actually centers for spreading disease. Where hogs are slaughtered it is more than probable that a hog infected with trichinæ will be killed. The offal of such a hog when eaten by rats will infect them, and these rats, if later killed and eaten by hogs, will again communicate the disease. Rats act as direct transmitters of trichinosis to hogs, and this is not the only disease which may be spread by offal feeding to hogs.

Old worn-out dairy cows are not infrequently killed at these houses, and from the large amount of tuberculosis found in this grade of cattle it follows that tuberculosis will be communicated to hogs feeding upon the offal.

The local slaughterhouse is also the center of infection for a number of animal parasites which are injurious to live stock, or in some cases even to man, and which are spread by dogs. It is well known that dogs come to such slaughterhouses for food, and when infected viscera are eaten by them they become infected, and through them infection

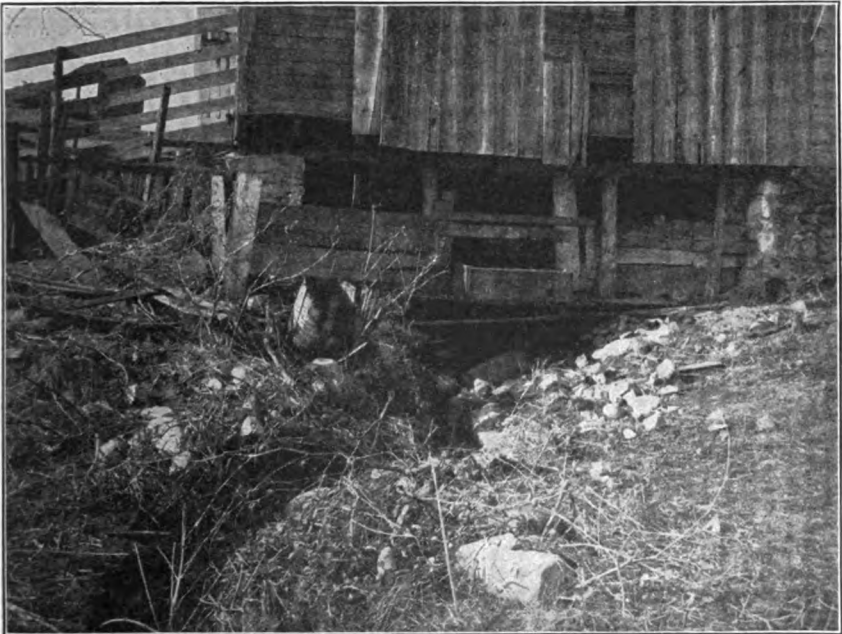


FIG. 1.—Insanitary conditions at small local slaughterhouse. Note the exposed drainage. Hogs are often fed on offal under such abattoirs, and rats and other animals have free access, thus favoring the spread of disease.

may be transmitted to other animals and to man. Several species of tapeworms are distributed in this manner.

Hog cholera is another disease which is spread from local slaughterhouses by improper disposal of the offal. This disease is communicated either by direct infection from hogs eating diseased viscera or by the infection being carried in rivers or creeks and spreading to farms lower down.

That the conditions which obtain at these local slaughterhouses need attention from authorities competent to deal with the situation is shown by a recent investigation made by the State board of health

of Indiana of those slaughterhouses which do not have Federal inspection. The report stated that—

Of the 327 slaughterhouses inspected, only 23, or about 7 per cent, were found to fulfill the sanitary standards. The standards called for in the Indiana pure-food law, approved March 6, 1907, were accepted, and said standards are as follows:

“Insanitary conditions shall be deemed to exist wherever and whenever any one or more of the following conditions appear or are found, to wit: If the slaughterhouse is dilapidated and in a state of decay; if the floors or side walls are soaked with decaying blood or other animal matter; if efficient fly screens are not provided; if the drainage of the slaughterhouse or slaughterhouse yard is not efficient; if maggots or filthy pools or hog wallows exist in the slaughterhouse yard or under the slaughterhouse; if the water supply used in connection with the cleansing or preparing is not pure and unpolluted; if hogs are kept in

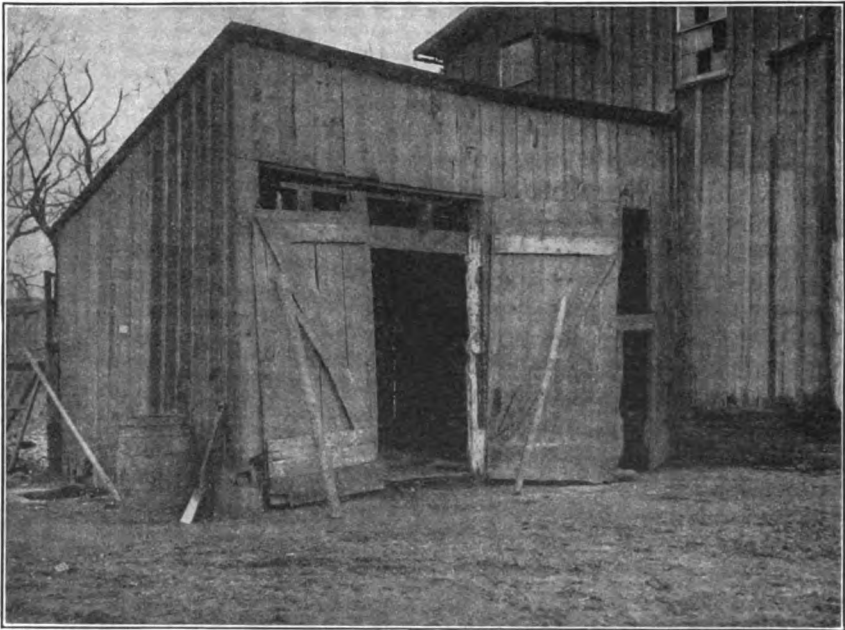


FIG. 2.—Place used as slaughterhouse and carriage house in suburbs of a city.

the slaughterhouse yard or fed therein on animal offal, or if the odors of putrefaction plainly exist therein; if carcasses or parts of carcasses are transported from place to place when not covered with clean white cloths, or if kept in unclean, bad-smelling refrigerators, or if kept in unclean or bad-smelling cold-storage rooms.”

At nearly all slaughterhouses inspected, foul, nauseating odors filled the air for yards around. Swarms of flies filled the air and the buildings and covered the carcasses which were hung up to cool. Beneath the houses was to be found a thin mud or a mixture of blood and earth, churned by hogs, which are kept to feed upon offal. Maggots frequently existed in numbers so great as to cause a visible movement of the mud. Water for washing the meat was frequently drawn from dug wells, which receive seepage of the slaughterhouse yards, or the water was taken from the adjoining streams, to which the hogs had access. Dilapidated buildings were the usual thing, and always the most repulsive surroundings and odors existed.

Slaughterhouses of fair sanitary condition were not found. They were all awfully and abominably bad or else met the standard completely.

A concrete example of conditions as they exist may be cited of a large eastern city. In this city there are 275 slaughterhouses which do not have Federal inspection. The approximate combined yearly kill at these plants is nearly 2,000,000 animals, as follows:

Cattle	38, 000
Hogs	516, 000
Sheep	1, 230, 000
Calves	108, 000
Total.....	1, 892, 000

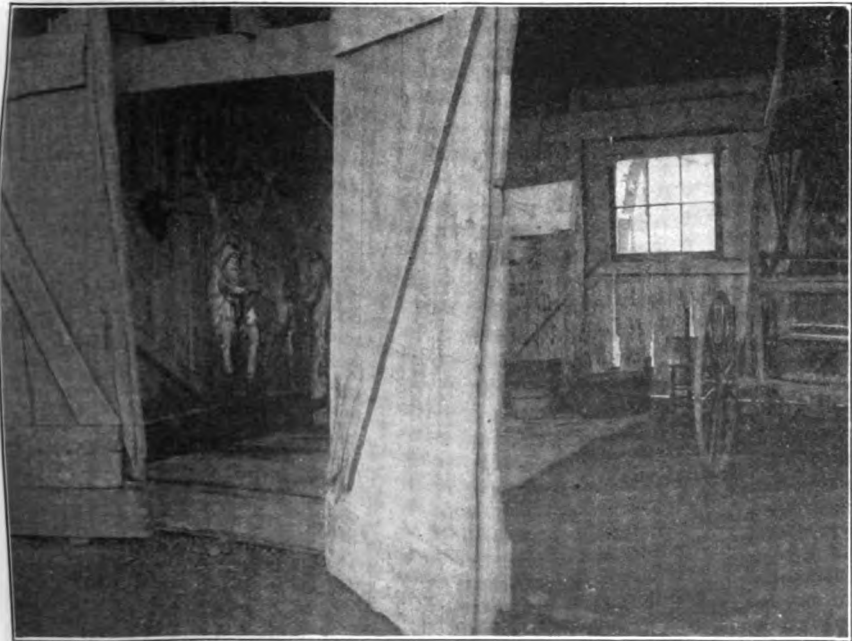


FIG. 3.—Interior of house shown in figure 2.

The meat-inspection force of this city consists of three men—one State inspector and two city inspectors—none of whom are veterinarians, but all of whom were formerly butchers. Their inspection necessarily must be hasty and superficial. It is, of course, a physical impossibility for these inspectors to make a post-mortem examination of all animals slaughtered. They merely make occasional visits to the killing beds, usually when cows are slaughtered.

One of the slaughterhouses of the larger sort in this city kills approximately 5,000 cattle, 150,000 sheep, and 50,000 calves a year, no hogs being slaughtered. This house has been described as follows:

The several departments of the establishment are each in a separate building. The killing department, for example, is in a large barnlike wooden structure.

It has one floor and a basement. Cattle, sheep, and calves are killed in the basement and on the first floor. The basement is floored with cement, but the flooring in the room above is of wood, filthy and insanitary. When slaughtering is being done, heads and hides are piled in heaps on the floor, and livers and tails are scattered about. Butchers frequently hold their knives in their mouths, wear grimy clothes, spit on the floor, and wash down carcasses with dirty water carried about in a bucket.

The ceilings, walls, and pillars are exceptionally dirty; blood and fecal matter besmear everything.

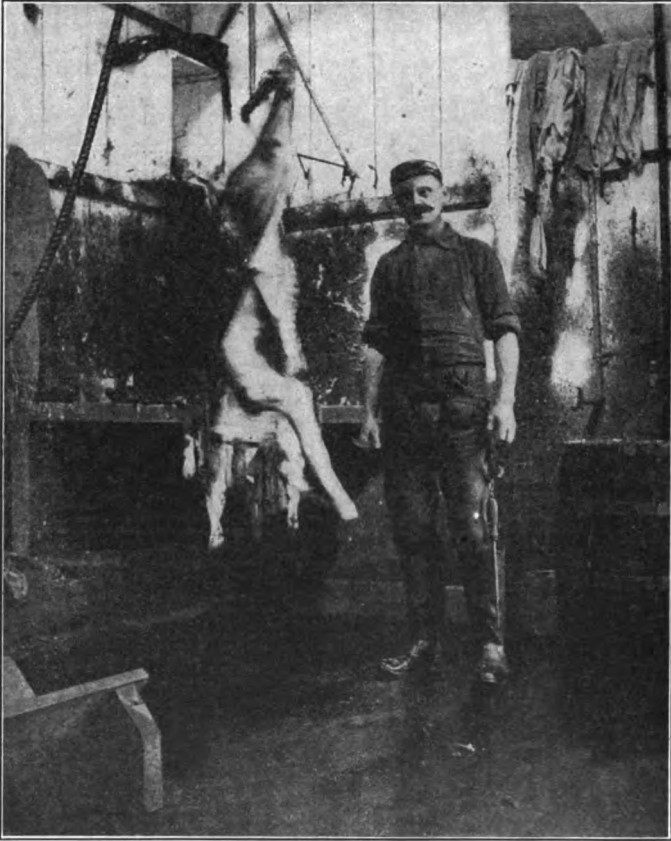


FIG. 4.—Calf-killing room in uninspected slaughterhouse. Observe filthy condition of walls and floor, and dirty clothes hanging on wall. This place handles 5 or 6 carloads of hogs and 10 to 15 cattle a week. The class of cattle killed is mostly worn-out dairy cows, many of which are tuberculous.

The trucks, trays, and other receptacles are filthy, as are the tables on which gut is removed. Chutes and cutting blocks are also dirty, and no effort is ever made to clean them. No toilet room is provided in the building.

The coolers or ice chests are in a revolting condition. The floors are wet and dirty, the walls damp. Livers are thrown on the floor; foul-smelling barrels are allowed to stand on the killing floor. The pens are in an inconceivably filthy condition. The top of the cooler is filled with cast-off shoes and clothes,

hides and cans, and other refuse. Old clothing, reeking with filth, is allowed to hang on the walls of the building.

One of the butchers was asked what they did with "sick" cattle. He laughed and answered, "What do they all do with them?" He told the inquirer that the butchers who killed at this establishment did so because they were afraid to kill where there was inspection, because the Federal inspectors would condemn sick cattle. This simply proves the butchers are carrying out their threat to kill dairy cows where there is no inspection, and thereby put into the meat food trade of the country carcasses which no Federal inspector would ever have passed.

In another large eastern city there are only four slaughterhouses in the city proper which do not have Federal inspection. The total kill



FIG. 5.—Interior of large slaughterhouse in an eastern city, showing insanitary conditions. Many animals which would be condemned under Federal inspection are slaughtered here and their meat is sold for local consumption. This place can not be reached by the Federal authorities, as its product is sold entirely within the State.

at these places is about 1,000 cattle and 2,500 hogs per month. The only inspection is furnished by one inspector of the board of health, and this inspector is not a veterinarian. Previous to his employment by the board of health he was a hotel porter. The sanitary condition of one of the establishments in this city is thus fairly described:

The place was built in 1872 and is falling to pieces, but little attempt being made to repair it. This slaughtering house is composed of three rooms or compartments, each about 20 feet square, only partly partitioned off. One of the compartments is used for the killing and dressing of hogs, one for lard making, and the other as a storeroom for manufactured lard, utensils, boxes, barrels, etc. The gut cleaning is done in the lard room. Steam from the scalding tub, and the foul odor always more or less present in hog-killing rooms, come in

direct contact with the lard in all stages of its manufacture and with the finished product. All floors are of wood and in a shocking condition. The place is supplied with running water, but the floors, walls, ceiling, tables, benches, etc., show but little evidence of its use. The loose material is swept from the floor, but the rest remains. Blood and manure are caked on the woodwork in places an inch thick. The blood and offal are conveyed by pipes and trapdoors to tank cars in basement, and from there taken to the rendering works. The cellar has a cement floor, but it is maintained in a filthy condition. There is no urinal, closet, or toilet connected with the place. The yard, pens, and runways are seldom cleaned, never during the winter months. There is manure in places a foot deep. Livers when first removed from the carcasses are thrown on the floor and later hung on dirty racks in the slaughtering room exposed to flies, filth, and the stench of the place.

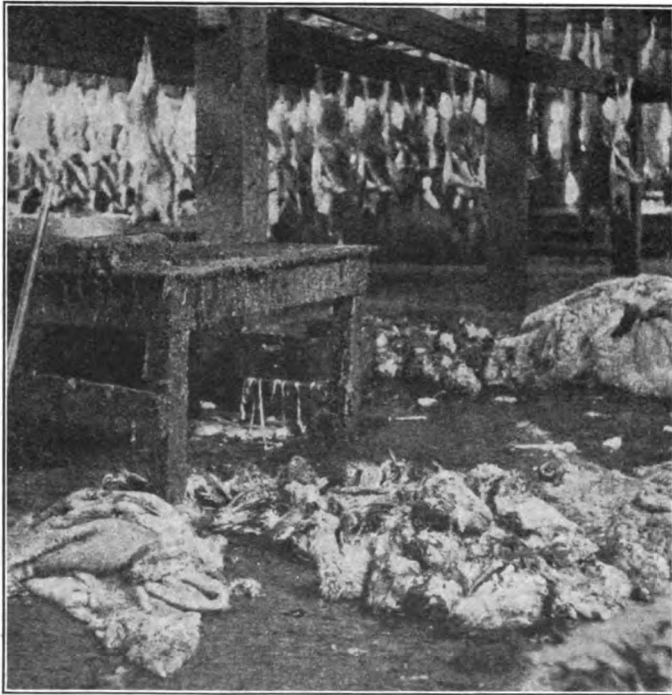


FIG. 6.—Another view of the same establishment shown in figure 5. Note filthy condition of table and floor; sheep pelts and heads strewn on floor.

By these few examples it can be readily appreciated that it is necessary to improve the efficiency of the inspection of meat and meat food products that are consumed entirely within a State.

MUNICIPAL SLAUGHTERHOUSES.

It is impossible to secure an effective system of local meat inspection without either a great increase in the number of competent meat inspectors employed or a concentration of the business of slaughtering. It is largely on account of the multiplicity of slaughterhouses

that thorough systems of meat inspection have not been more generally established. In the small houses very frequently the slaughtering is done at night or very early in the morning, and it would necessitate the employment of a small army of meat inspectors to provide a sufficient number so that one should be present at each place.

The plan of concentration of slaughtering is supported by the experience of all the older civilized countries. It is recommended not only because it facilitates the inspection of meat but because of numerous other advantages. Since the local slaughterhouses are especially prolific sources for the spread of disease, the segregation of such places would materially reduce the number of centers of infection. It would eliminate all of the small, poorly built, badly managed slaughterhouses which are in many instances nuisances in their respective neighborhoods. It would give the small butchers the advantage enjoyed by wholesalers and the large packers, as they could use the machinery installed and the increased facilities supplied in the way of an abundance of hot and cold water for cleansing purposes, all of which are greatly superior in a large plant. The refrigeration also is much better in such a plant and would result in increased wholesomeness of meat to the consumers. The character of the local meat supply would gain in reputation, and local meats could enter into competition with those supplied by the large packers. Unless there is a competition of this kind the tendency of the trade at present is that the large packers will control the supply.

Instead of increasing the cost, the tendency of centralization is to reduce it. A large establishment conducted by cooperation among the butchers would naturally entail less expense than a number of small ones. Moreover, such a system is a great safeguard to the consumer of meats, while it subjects the butchers to no hardships whatever, but makes it more convenient and cheaper for them to conduct their trade. In Europe such union or central abattoirs are owned by the municipalities, and undoubtedly this is the best system, since all butchers are assured of equal rights and privileges. Germany has more than 600 slaughterhouses belonging to municipalities.

If cities and towns of the United States are not prepared to adopt the plan of municipal abattoirs they can at least require a segregation of slaughtering and require animals to receive a careful post-mortem inspection at the time of slaughter.

INCREASED VALUE OF BY-PRODUCTS.

One immense advantage to be derived from the consolidation of slaughterhouses would be the increased value received from the by-products, which are practically lost by the small slaughterers.

That the value of such by-products is an important item is apparent from the statement of Mr. J. Ogden Armour, made to the

Bureau of Corporations in the recent investigation of the beef industry. He spoke as follows:

The ability of wholesale butchers in the small towns to compete with the large packers in the sale of beef depends entirely upon conditions. At times such butchers can buy cattle so cheap that the large packers are almost excluded from doing business in their towns. When such a butcher has to buy his cattle in the same market that the large packers do, we are able, through our economies in manufacture and through making articles of value out of what would go to waste in his establishment, to sell to the retailers at a lower price than the local wholesale butcher can do.

From this statement and from other statements of a similar kind made in the investigation referred to, it is evident that the value of the by-products is an important source of profit; in fact, it has been stated that the packing business of to-day would be carried on at a loss but for the utilization of the by-products. Whether this be true or not, it must be conceded that the saving of these products and converting them into articles of commercial value is a powerful argument for the centralization of small slaughterhouses. It is by this plan of concentration that the modern packing business has grown to its present magnitude, and by following the same plan it is possible for the small butcher to reap substantial rewards.

We must bear in mind that when animals are slaughtered not all of the product is edible meat. Fat cattle, for instance, dress only about 60 per cent of the live weight, sheep 50 per cent, and hogs 80 per cent. The remainder need not be destroyed and become a total loss if there are proper facilities for handling it. This is done in modern abattoirs, but can not be accomplished where there is not suitable equipment. From packing-house statistics it appears, in the case of cattle, that the value of the hide and offal would probably increase the total percentage to 75. In other words, the 40 per cent of offal is equivalent in value to about 15 per cent of meat.

The most valuable product, next to the beef, is the hide, which of course is usually saved by country butchers. But in large abattoirs where many cattle are killed the removal of the hide is so skillfully done that its value is much greater. Tanners pay three-fourths to 1 cent a pound more for such hides than they do for country hides, which are often cut or damaged in stripping.

The next important item is the tallow, which, when properly treated, becomes valuable in the form of oleo oil and stearin. The feet, from which neat's-foot oil is extracted, the bones of the skull, the horns, and even the sinews, may be utilized. When machinery is available for proper preparation, the casings, which are entirely lost in small slaughterhouses, yield a good return, thus saving the expense of importing from foreign countries, which is now done to a large extent.

Other by-products, such as tongues, livers, sweetbreads, beef hearts, tripe, and blood albumen, with proper attention and refrigeration, can be available for food, where formerly they were thrown away as useless and not worth the trouble required to keep them.

The tankage is still another product which is of value. The liquid that is pressed out of the tankage is saved, and, after boiling and treating with chemicals, is known as "concentrated tankage" and is sold on an ammonia basis.

An accurate idea of the value of slaughterhouse by-products can be gained by referring to an example cited in F. W. Wilder's book, *The Modern Packing House*. This book is an acknowledged authority on the packing business, and the data presented refer to the yield of a bunch of 34 cattle, obtained in actual operation at the prevailing market prices (1905).

Yield of 34 cattle.—Average live weight, 1,259 pounds; average dressed weight, 750 pounds; average weight of hide, 89 pounds. Excluding the dressed meat and the hides, the remainder (offal) realized as follows:

"Trimnings" (tongues, livers, hearts, tails, head meat, etc.)	\$42. 03
Casings	17. 73
Sweetbreads	1. 80
Tripe	3. 55
Heads and feet	33. 99
Blood	4. 82
Sinews	. 46
Tallow (converted into oleo oil and stearin)	252. 42
Total	356. 80

In addition to the above there were 2,665 pounds of "tankage," being 78.38 pounds a head. This tankage consists of the bony portions of the heads, and all the other refuse of the slaughtering operations. This material is rendered in the tank, and after extracting the fat the residue is converted into more or less valuable by-products, as ammonia, etc. This matter of tankage, in particular, illustrates the close business methods that are being applied in the modern abattoir.

However, taking the total value of the offal, including tallow, as given above, and dividing by the number of cattle experimented with (34), the value of offal per head is seen to be \$10.49. If to this is added the tankage at \$16 a ton, the total is increased to \$11.05. Assuming that the animals cost an average of \$80 a head alive, the offal then amounted to fully 14 per cent of the live value, which gives a good indication of how much may be lost through wasteful methods. Similar economy is exercised in the slaughter of sheep and hogs; it is therefore unnecessary to go into details in regard to these classes of

animals. What has been said shows without doubt that the loss of the whole or any considerable part of the by-products would make a very appreciable difference in a year's operation at any good-sized abattoir.

It would seem, if for no other reason than the saving of these by-products, that concentration in slaughtering and competent inspection should be advocated and upheld from a commercial point of view.

PUBLIC EFFORT NECESSARY FOR REFORM.

Since the Federal law will not permit meat slaughtered under the insanitary conditions herein mentioned to enter into interstate and foreign trade, nothing remains but for it to be consumed within the State; it is therefore necessary for public opinion and effort to bring about a more cleanly and healthful condition in this direction. Let organizations having similar objects in view as this bring before the people the revolting conditions under which some of our meat is supplied and public sentiment will soon force those in authority to take measures to better these conditions.

This question of an adequate State inspection of meat was emphasized by Miss Alice Lakey, chairman of the food committee of the National Consumers' League, in an address delivered at the Jamestown Exposition July 19, 1907, in connection with the eleventh annual convention of the Association of State and National Food and Dairy Departments. Miss Lakey said, in part:

Will not this body of State and National officials use its influence to help in prevention by securing State inspection of cattle, slaughterhouses, and meat? Why are so many consumers acceding to the demands of the meat trust by paying increased prices for meat? Because such meat bears the stamp of the Federal inspector and the consumer has been educated by the public press to believe that such meat is safe. Many consumers refuse all meat not so labeled. Can not the States give consumers a label on State meat that shall be equally reassuring?

It is only fair to say, in conclusion, that a packer who submits to Federal inspection and destroys all animals that are unfit for food purposes incurs a heavy expense not known to the slaughterer who has no inspection of any kind and who sells diseased meat at the same price that he receives for healthy meat. Consequently the packer or slaughterer whose product is subjected to a rigorous inspection should receive, in all fairness, a higher price for his product than the packer or slaughterer who operates without inspection.

636, 073

U 5-8

B95C

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 155: 1910

A. D. MELVIN, CHIEF OF BUREAU.

APR 21 1910

MYCOTIC LYMPHANGITIS OF HORSES.^a

By JOHN R. MOHLER, V. M. D.,
 Chief of the Pathological Division.

This disease has been known as epizootic lymphangitis, otherwise pseudo-farcy, or Japanese farcy; it is a chronic contagious disease, particularly of equines, caused by a specific organism, the *Saccharomyces farciminosus*, and characterized by a suppurative inflammation of the subcutaneous lymph vessels and the neighboring lymph glands. Owing to the fact that this affection does not spread as an epizootic and that its causal factor is a yeastlike fungus, the name mycotic instead of epizootic lymphangitis is suggested. This disease was first described by Italian and French veterinarians, and the specific organism was discovered by Rivolta in 1873. The presence of the disease in the United States was first observed by Pearson in Pennsylvania in 1907, although it is probable that it has existed in various parts of this country for many years. More recently its presence was definitely established in Ohio, Iowa, California, and North Dakota, and there is a probability of its existence in Indiana and several Western States. The disease is also present in the Philippine Islands, Hawaiian Islands, and Porto Rico.

BACTERIOLOGY.

The *Saccharomyces farciminosus* forms slightly ovoid bodies 3 to 5 microns long and 2.4 to 3.6 microns broad, which are somewhat pointed toward the poles and have a sharp double contour. They have more or less of a homogeneous content and grow by budding. This characteristic can be especially well observed in old growths on culture media. Their staining with the ordinary stains is quite unsatisfactory; they may, however, be readily recognized in fresh smear preparations or in the hanging drop of a small quantity of the suspected pus, where the above-described bodies can be distinctly noticed.

A satisfactory method of staining the organism is the Claudius method, which is as follows:

1. Stain with 1 per cent aqueous solution of methyl violet for two minutes.
2. Wash in water.

^a Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry (1908).

3. Place in a half saturated solution of picric acid for one to two minutes.

4. Decolorize with chloroform or clove oil.

5. Treat with xylol.

6. Mount in Canada balsam.

The organisms grow very slowly in the various culture media. It requires about ten days before vegetation is noticed on agar in the form of grayish-white granules, which gradually grow to larger colonies, appearing considerably elevated and having a wrinkled

surface. They also grow in bouillon, in which a white flaky deposit makes its appearance after fifteen or eighteen days. In taking cultures it is advisable to open a fluctuating abscess, over which the skin should be shaved and well cleaned with bichlorid solution and alcohol. The abscess should be opened with a sterilized scalpel, and culture media may then be inoculated in the usual way. In case of a mixed infection, the organism may be isolated by plating.

The period of incubation varies greatly, extending from three weeks to four months, or even longer. In artificial inoculations with pus through wounds in the skin, inflammation and swelling of the lymph vessels may be noticed in twenty to sixty days, and these vessels show in their course a development of hard nodules, from which abscesses form.



FIG. 1.—Mycotic lymphangitis in North Dakota mare.

The natural infection is without doubt caused through superficial wounds, such as galls, barbed-wire cuts, or through various stable utensils, harness, bandages, insects, etc. Solipeds are mostly susceptible, but cattle may also be infected.

SYMPTOMS.

The inflammation of the lymph vessels is usually first observed on the extremities, especially on one or both hind legs (fig. 1); it may also appear on the fore legs, shoulder, or neck (figs. 2 and 3), and more rarely on the rump, udder, and scrotum.. The lesions as a rule



FIG. 2.—Mycotic lymphangitis on foreleg and shoulder of horse.



FIG. 3.—Mycotic lymphangitis in Porto Rican pony.

develop in the tissue adjacent to the place of inoculation. In the early stages of the disease the lymph vessels appear very hard and thickened, and along their course hard nodules develop, ranging in size from a pea to a hen's egg. Later these nodules soften, burst spontaneously, and discharge a thick yellowish pus. The surface of the resulting ulcers or abscess cavities soon fills up with exuberant granulation which protrude beyond the surface of the skin, giving a fungoid appearance. The affected extremities are considerably enlarged, similar to cases of simple lymphangitis. In rare cases the mucous membrane of the nostrils may also become affected, showing yellowish flat elevations and ulcerations, and these may extend by metastasis to internal organs. (See fig. 4.) In cases where the mucous membrane is affected the submaxillary lymph gland may also become enlarged and suppurate.

The constitutional symptoms accompanying this disease are not very marked or may be altogether absent. There is usually only a very slight fever, which seldom runs over 102° F. The appetite is not impaired except in the advanced cases.

LESIONS.

The anatomical changes are most marked in the skin and the subcutaneous tissues. They may become 2 to 3 inches thick and indurated as the result of fibrous-tissue formation, due to the inflam-

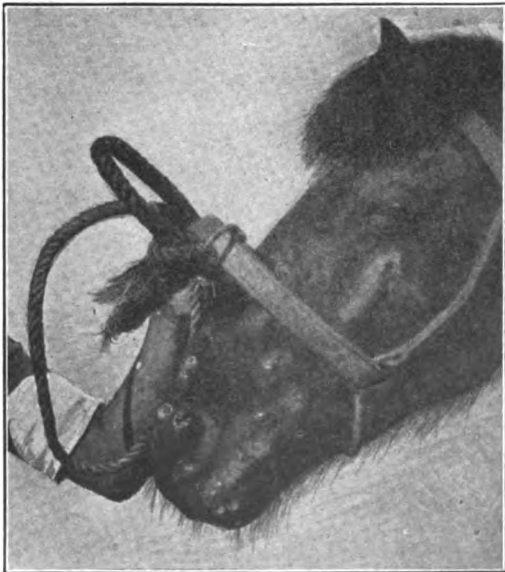


FIG. 4.—Mycotic lymphangitis in Philippine pony.

mation present. On the baconlike cut surface suppurative areas and granulating sores may be noticed of various sizes, also enlarged lymph vessels filled with clotted lymph mixed with pus. The neighboring lymph glands are usually enlarged and frequently contain suppurating foci. Rarely the internal organs may show metastatic abscesses.

DIAGNOSIS.

The diagnosis is based on the characteristic appearance of the ulcerations,

which show exuberant granulation of a bright-red color, inverted edges, and a thick, creamy, glutinous discharge. These manifestations differentiate the disease from glanders, in which the ulcers

are craterlike, do contain exuberant granulations, and the discharge is of a viscous, oily character. The submaxillary and other nodes as well as the corded lymphatics in glands are more firmly attached to the adjacent tissues, and are therefore less movable. In some chronic cases of mycotic lymphangitis, however, the lesions may closely resemble those of farcy, and in these cases the microscopical examination of the pus will disclose the nature of the affection. In the pus the saccharomyces can be easily seen in the unstained specimen and is recognized by its size, shape, and highly refractory double outline. Furthermore, the injection of mallein in cases of mycotic lymphangitis will be attended with negative results.

TREATMENT.

Treatment consists at the onset of the disease in entire extirpation of the nodules, lymph vessels, and neighboring lymph glands in case the lesions are localized. In cases where the nodules have formed abscesses their opening is recommended, followed by the application of the actual cautery or a 1 to 250 solution of bichlorid of mercury. It must be borne in mind that the organism is highly resistant to almost every antiseptic, and the best results will be obtained from the application of a solution of a strong antiseptic following the opening of the lesions.

In the most favorable cases recovery results in from five to seven weeks; as a rule, however, it requires several months.

PROPHYLAXIS.

In order to prevent the spreading of the disease the affected animals should be isolated, the products of the disease should be destroyed, and the stable should be disinfected with very strong liquid disinfectants in consideration of the great resistance of the causative organism.



636013
258
B95c

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 156. UNIV. OF MICH.
A. D. MELVIN, CHIEF OF BUREAU. APR 21 1910

CHRONIC BACTERIAL DYSENTERY OF CATTLE.*

By JOHN R. MOHLER, V. M. D.,
Chief of the Pathological Division.

Chronic bacterial dysentery is a chronic infectious disease of bovines caused by an acid-fast bacillus simulating the tubercle bacillus. It is characterized by marked diarrhea, anemia, and emaciation, terminating in death. It has also been termed by various European investigators Johne's disease, chronic bacterial enteritis, chronic hypertrophic enteritis, and chronic bovine pseudo-tuberculosis enteritis.

Recently this disease has been observed in the United States for the first time by Pearson in Pennsylvania cattle, and later by Beebe in Minnesota and by Mohler in Virginia cattle and in an imported heifer from the Island of Jersey at the Athenia, N. J., quarantine station of the Bureau of Animal Industry. Pearson has proposed the name "chronic bacterial dysentery" for this affection.

The disease was first studied in 1895 by Johne and Frothingham in Dresden, but they were inclined to attribute the cause of the peculiar lesions of enteritis which they observed to the avian tubercle bacillus. In 1904 Markus reported the disease in Holland, and subsequently it was observed in Belgium, Switzerland, Denmark, and Great Britain.

CAUSE.

The bacillus which has been invariably demonstrated in the intestinal lesions and mesenteric lymph glands in this disease is a rod about 2 to 3 microns long and 0.5 micron wide. It stains more or less irregularly, like the tubercle bacillus, and, moreover, the similarity goes farther in that the organism is also strongly acid-fast, which facts led Johne and Frothingham to surmise that the disease was caused by avian tubercle bacilli. However, it has now been plainly demonstrated that the bacillus of chronic bacterial dysentery is readily distinguished from those organisms, for while it resembles the tubercle bacillus in form and staining qualities, no one has suc-

* Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry (1908).

ceeded in growing it in culture media or in reproducing the disease by injecting experiment animals.

SYMPTOMS.

Probably the first symptom noticed is that the animal is losing condition despite the fact that its appetite is good and the feed nourishing. This is soon followed by a diarrhea which is moderate at first, but soon becomes excessive and may be either irregular or persistent, the feces being of the consistency of molasses and passed frequently. In the meantime the hair becomes dry and harsh and the animal falls off considerably in weight. (See fig. 1.) The temperature, however, remains about normal. The appetite does not seem to be greatly

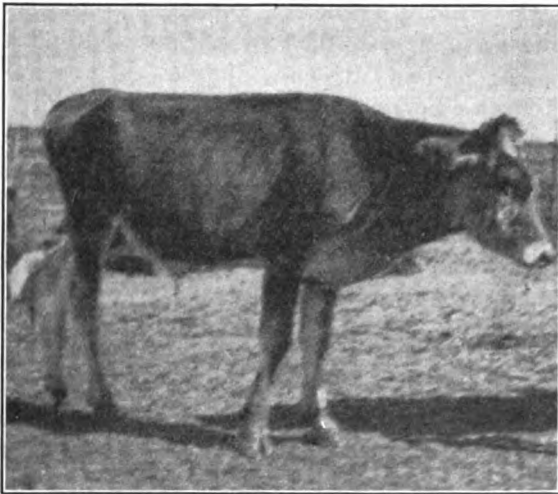


FIG. 1.—Steer affected with chronic bacterial dysentery.

impaired until the last few weeks of life, but nevertheless emaciation continues, the animal becomes more and more anemic, great muscular weakness and exhaustion are manifested, and death follows, apparently as the result of the persistent diarrhea and great emaciation. The disease may continue for four or

five weeks or may last for a year or even longer before death intervenes.

LESIONS.

The lesions observed on post-mortem are remarkably slight and out of all proportion to the severity of the symptoms manifested. The disease appears to start in the small intestines, especially in the lower portion, where the lesions are usually the most marked, but it also involves the large intestines, including the rectum. The mucous membrane may alone be affected, although usually in the long-standing cases the submucosa is also invaded, and the entire intestinal wall is then much thicker than normal and the tissue infiltrated with an inflammatory exudate. The mucous membrane or inside lining membrane is markedly wrinkled or corrugated, showing large coarse folds with more or less reddening or hemorrhagic patches or spots on the summits of the ridges, especially noticeable in the large intestines.

[Cir. 156]

The mesenteric lymph glands are usually somewhat enlarged and appear watery on section. The other organs do not appear to be affected except from the anemia present in the later stages of the disease.

DIFFERENTIAL DIAGNOSIS.

The principal disease with which bacterial dysentery may be confused is tuberculosis, but the application of the tuberculin test will readily diagnose the latter disease, while no reaction will be noted in case the injected animal is suffering with only the former affection. The disease may also be mistaken for the parasitic affections resulting from stomach worms (verminous gastritis) and intestinal parasites, especially uncinariasis, in which case a microscopic examination of the feces is necessary in order to establish definitely the diagnosis.

TREATMENT.

As with all other forms of infectious disease, it is advisable to separate immediately the diseased and suspected cattle from the healthy animals. The feces passed by the former should be placed on cultivated soil where healthy cattle would not be exposed to them, as the bacilli producing the disease are readily found in such manure. The stalls, stables, and barnyards should also be thoroughly disinfected, special attention being given to those places which have been soiled by feces.

The administration of medicines has thus far been quite unsatisfactory, although treatment should be directed toward disinfecting the intestines with intestinal antiseptics, such as creolin in 2-teaspoonful doses given twice daily. Salol, turpentine, or subnitrate of bismuth in a starch or wheat-flour gruel may also give temporary relief, but the diarrhea is likely to reappear and cause the death of the animal. In all cases the food must be carefully selected to assure good quality, and should consist preferably of nutritious dry feed.

[Cir. 156]



THE PREVENTION OF LOSSES AMONG SHEEP FROM STOMACH WORMS (*HÆMONCHUS CONTORTUS*).^a

By B. H. RANSOM, Ph. D.,
Chief of the Zoological Division.

INTRODUCTION.

The important problem of how to prevent losses among sheep from stomach worms is one for which, apparently, no solution that meets the wants of the practical sheep raiser has yet been discovered. After a preliminary investigation of the question it was hoped that such a solution might be reached, but in the light of further study of the life history of the stomach worm, combined with various experiments on sheep and lambs, the writer is less sanguine in regard to the matter.

Before proceeding to a consideration of measures which may be taken to avoid the injurious effects of stomach worms it may be well to discuss briefly some of the points relative to the behavior and life history of these parasites which have been brought out by investigation and experiment.

It is commonly noted that lambs are more severely affected by stomach worms than older sheep. The former become pale, thin, and weak, and finally die, or continue for a long time in poor condition and fail to grow as they should, while the adult sheep of the flock may remain in apparently good health. In such cases, however, it will be found if some of the older sheep are killed and examined that they as well as the lambs are more or less heavily infested with stomach worms. The reason, therefore, that the lambs are affected and the adult sheep are not, is because the latter possess a tolerance toward stomach worms not shared in an equal degree by the lambs.

The injurious action of stomach worms may be attributed to two things: First, the loss of blood abstracted by the parasites and the loss of nutritive materials which may be absorbed by the parasites from the alimentary fluids, and, second, the destruction of red corpuscles by a poisonous substance secreted by the parasites which is absorbed into the blood. Evidently the older, stronger, and larger sheep are better able than the lambs to withstand the losses of blood and nutritive materials and can better endure the loss due to the destruction of red corpuscles. Furthermore, there may be substances present in the blood of adult sheep tending to neutralize the poisonous matter produced by the parasites that are absent from the blood of the lambs,

^a Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry (1908).

or that, if present, occur in smaller quantities. It is barely possible that some means of artificially producing in lambs an immunity against the evil effects of stomach worms may be devised, but at the present time this is only a matter for speculation and experimental research. Our present knowledge of the stomach worms leads us to direct our efforts toward bringing about freedom from infection, or, as the next best thing, reducing the amount of infection to a minimum and keeping it there.

LIFE HISTORY OF THE STOMACH WORM.

In the adult sexual stage stomach worms are able to live and carry out their reproductive functions only in the alimentary canal of sheep or other ruminants, occurring in the largest numbers in the fourth stomach. Each female produces thousands of eggs of microscopic size which do not develop into adult worms in the body of the host in which they are deposited, but, without hatching, pass out of the intestine in the feces. In a few hours, days, or weeks, according as the temperature is high or low, these eggs, if they are not killed by dryness or freezing—either of which is fatal to them—hatch out, and the tiny embryonic stomach worms then develop to what may be termed the final larval stage, or infectious stage. This later development likewise requires days or weeks, according to the temperature, and until the embryos have reached the infectious stage they appear to be fully as susceptible to freezing and drying as the eggs. Having reached the infectious stage, however, the worms are able to withstand long periods of dryness and severe cold, though some of them succumb comparatively early.

In the infectious stage the young worms are very active in the presence of moisture, and rapidly crawl up blades of grass and other objects whenever the relative humidity of the air is at a maximum, provided the temperature is above 40° F. or thereabout; below this temperature they are inactive. A decrease in the relative humidity, with the consequent evaporation of the moisture from the surface of grass blades and other objects, stops the migrations of the worms, and they become quiescent and remain in a condition of suspended animation wherever they happen to be at the time. During the next period of wet weather, dew, rain, or fog, they again become active and climb still higher on the grass. This crawling up grass blades is evidently most advantageous to the worm, as it thereby gets into a position from which it is much more likely to attain its final abode within the stomach of a sheep or cow than if it stayed down on the ground. When swallowed by a sheep or other ruminant, the embryonic stomach worm, if it has reached its final larval stage, whether active at the time or in a state of suspended animation, continues

its development and in the course of two or three weeks has reached maturity.

The length of life of individual worms in the stomach has not been determined. We have kept infested sheep in pens with board floors which were kept clean by sweeping and frequent scrubbing, feeding the sheep from raised racks and supplying water in a trough which was frequently cleaned, for varying periods up to a maximum of nineteen months, and found them still infested. As the possibility of reinfection by larval worms developing from eggs passed in the feces of these sheep was not entirely removed, though greatly minimized, the results obtained do not necessarily indicate that the worms present at the end of the period of observation were all present when the experiment was begun. The experiment, however, while it proves nothing as to the length of life of the adult stomach worm, demonstrates the futility of attempting to rid sheep entirely of stomach worms by simply keeping them away from pasture.

TREATMENT OF PASTURES.

The maximum period during which the larval stomach worms are able to survive on pastures is not definitely known, but it has been found that pastures on which infested sheep had grazed were apparently still infectious after a lapse of nearly eight months, namely, from October 25, when the infected sheep were removed, to June 16, when the pastures were tested by placing in them some lambs which had been raised under special precautions to avoid previous infection. In cultures made September 14, 1906, from the feces of an infested sheep and kept thereafter in the laboratory, most of the larvæ were dead but some were still alive, though very sluggish, on June 5, 1907, nearly nine months later. Cultures in which the embryos were allowed to develop to the final larval stage, after which they were kept in cold storage at temperatures below freezing—in some cases as low as 12° F.—still contained some living embryos after two or three months, while in other cultures eggs and embryos not yet developed to the final larval stage were killed within a few hours when exposed to temperatures below freezing. These experiments show that pastures may remain infected for several months after sheep are removed from them, and that the infection is not destroyed by cold weather. They also show that during a winter with more or less freezing weather there will be little or no increase in the amount of infection in pastures occupied by infested sheep. The eggs passed in the feces of the sheep will either be killed at once by freezing, or, on account of low temperatures above freezing, will remain dormant or develop so slowly that they are killed later by frost before they have reached the final

larval stage, which is resistant to cold. At the same time, while the infection of pastures may not be increased during the winter, the infestation of the sheep may be added to by their picking up from time to time larval worms which, prior to the beginning of cold weather, had already developed to the stage in which they are able to withstand freezing.

If sheep, goats, and cattle are kept out of a pasture for a year, it is fair to assume, upon the basis of our present knowledge, that all, or practically all, larval stomach worms will have died within this time. There is also little doubt that the period required for practically accomplishing disinfection of a pasture may be considerably shortened by plowing it up and placing it under cultivation. There are thus two ways by which a pasture may be disinfected, one by excluding sheep or other ruminants for at least a year, and the other by turning the pasture into a cultivated field. In view of the fact that any sheep which may be placed on disinfected fields or pastures will probably not be entirely free from infestation, it is not of much consequence whether every larval stomach worm in the pastures is dead or not. The approximation to this point which is attained by vacating pastures for a year or by plowing them up is sufficient for practical purposes.

METHODS OF PREVENTING THE DISEASE.

Taking up the question of preventing stomach-worm infection, it appears that at the present time the only method of handling lambs born of infested ewes that can be guaranteed to keep the lambs free from stomach worms is a method which is so impracticable that it is not likely to come into general use. As soon as born the lambs would have to be taken away from their mothers and raised by hand, never allowed to suckle, and be kept by themselves in places not previously occupied by sheep, cattle, or goats, all of which being subject to stomach worms are liable to leave infection wherever they happen to have been, which, it has been noted, may persist for many months. The possibility of the embryos of stomach worms reaching these places by drainage from infected areas, in hay cut from infected meadows, or in barnyard manure used for fertilizer, would also have to be excluded. Furthermore, the milk fed to these lambs, whether from sheep, goats, or cattle, would have to be pasteurized or sterilized in order to avoid the possibility of infection from this source, as some of the tiny embryos of stomach worms which might be present on the skin, wool, or hair of the animal from which the milk is drawn would be very likely to get into the milk during the process of milking and thus ultimately find their way into the stomachs of the lambs. Simple filtration of the milk would not insure the removal of the worms.

The experiment of filtering liquids containing embryonic stomach worms has been tried, using filter paper of the kind commonly used in laboratories for ordinary filtration, with the result that the worms readily passed through the filter.

THE BARE-LOT METHOD.

Methods of preventing stomach-worm infection less stringent than this have been tried with imperfect results. In the bare-lot method of raising lambs, devised by Dalrymple, the ewes and lambs are kept in an inclosure as free from vegetation as it can be kept, and are fed and watered from raised racks and troughs. Dalrymple found that when this method was used the lambs did not escape infection, and we have had similar experience.

PASTURE ROTATION.

In 1908 at the Experiment Station of the Bureau of Animal Industry near Washington, ten inclosures were constructed in a large field which had not been occupied by sheep or other ruminants for many years. Into inclosure No. 1 were placed a number of ewes and lambs which from the time the latter were born had been kept in separate pens except when turned together at intervals into another pen in order to enable the lambs to suckle, this pen being cleaned after each suckling period.

Prior experiments had indicated that the eggs and newly hatched embryos of the stomach worm would not develop to maturity if swallowed by sheep, and that the embryos must first develop to the final larval stage before they are able to complete their development when swallowed. In view of the fact that more or less time is required for the development from the egg stage which is found in the fresh feces of infested sheep to the final larval stage in which the young worms are ready to be swallowed, it was thought that the lambs might be kept for a time with the ewes in inclosure No. 1 without danger of infection, the danger point being reached when the sheep had been in this inclosure long enough for embryos to develop to the infectious stage from eggs in the feces of the infested ewes. In order to determine when the danger point would be approached cultures were made from the feces of an infested sheep two days before the ewes and lambs were placed in inclosure No. 1.

These cultures were kept outdoors near the inclosures and examined from day to day, other similar cultures being made at intervals of two to three days. As soon as it was found that the stomach-worm eggs present in any of the cultures had hatched and that the embryos had developed to the final larval stage, the lambs and ewes were moved to inclosure No. 2 in order to avoid infection with embryos in the in-

fectious stage, which the test cultures indicated would appear in this stage in inclosure No. 1 a couple of days later.

When the sheep and lambs were moved to inclosure No. 2, test cultures were again used as a guide to determine when the animals should be moved to inclosure No. 3, and so on throughout the entire series, the lambs alone finally being placed in inclosure No. 10. When the lambs were killed and examined after they had been in this inclosure about six months—namely, from July to December—some of them were found to be infested with stomach worms.

The infection of the lambs was evidently due to one or both of two things, namely, they became infected from larval stomach worms on the skin and wool of the ewes, whence the parasites were taken into the mouth by the lambs while suckling, or they became infected from worms which developed to the infectious stage in the various inclosures more rapidly than the test culture indicated. In either case it is clear that during the summer lambs can not be entirely protected from infection if kept with infested ewes, even though the flock be placed on fresh pasture at intervals much shorter than would be possible under practical conditions. In the experiment the sheep averaged less than nine days in each inclosure. Relatively few embryos in the test cultures had developed to the infectious stage when the sheep were changed from one inclosure to the next, the development of the majority proceeding much more slowly; but as it was desired in this experiment to keep on the safe side the sheep were moved as soon as the first appearance of embryos in the final larval stage was noted in the cultures. Even though the periods during which the sheep remained in the various inclosures had been lengthened to correspond to the periods required for larvæ in the infectious stage to become abundant in the cultures, the changes would still have been more frequent than would be practically possible, owing to the large number of clean pastures that would be required.

THE SUCKLING-PEN METHOD.

Dalrymple's plan of having a special suckling pen has also failed to prevent entirely stomach-worm infection in lambs from infested mothers. In the latest experiment with this method which has been carried out in this Bureau the ewes and lambs were placed in two small pastures which were free from infection at the beginning of the experiment, not having been occupied by sheep or other ruminants for a period of several years, the lambs occupying one pasture and the ewes the other. Until the lambs were weaned they were allowed with the ewes at frequent intervals for suckling in a small, bare pen from which all droppings were removed after each period of occupancy. After weaning, the lambs remained in the pasture which they had occupied before until some months later, when they

[Cir. 157]

were killed and examined. Most of them were free from stomach worms, but in some the parasites were present in small numbers.

In earlier experiments the suckling-pen method gave more favorable results, and the writer was led to believe that it might be of some practical use. Since it can not be depended upon absolutely to prevent infection in lambs, as shown by the latest experiment, it is probably not of much practical value. It is not, however, a very troublesome method, as the ewes and lambs soon learn their way back to their proper pastures, and are easily separated after each suckling period. A noninfected pasture is required for the lambs, and since this pasture would become more or less infected as a result of the failure to prevent absolutely the infection of the lambs, it becomes necessary to employ a different pasture for the next crop of lambs, using the same pasture only in alternate years and excluding all ruminants from it in the interim in order to allow any infection which may be present to die out. However, fields adjacent to the ewe pasture might be utilized temporarily as pastures for the lambs and the necessity of maintaining two permanent lamb pastures thus avoided.

The failure of this method to prevent infection entirely is probably due to a circumstance already mentioned, namely, the more or less common occurrence of larval stomach worms upon the skin and wool of the ewes, whence they may sometimes be taken into the mouth of the lambs while suckling and be swallowed.

Inasmuch as there is no known method of handling lambs from infested mothers so as to avoid absolutely stomach-worm infection, with the exception of that in which the lambs are raised by hand, we must be content with reducing the amount of infection as much as possible and keeping the sheep and lambs in as good physical condition as practicable, so that they may be better able to tolerate the parasites from which they can not escape. In some cases it may be possible to employ the suckling-pen method to advantage in spite of its apparent impracticability. As to schemes for avoiding infection by the rotation of pastures, it is evident that a rotation plan, in which an attempt is made to keep pace with the development of the embryonic stomach worms by moving the sheep from one pasture to another before embryos hatching from eggs passed in the feces of infested members of the flock have developed to the infectious stage, is out of the question.

COMBINED PASTURE ROTATION AND MEDICINAL TREATMENT.

Recognizing the impracticability of moving sheep from one pasture to another frequently enough to avoid entirely the infection which develops in the pastures, we may next consider a plan for reducing infection by a combination of occasional rotation and

medicinal treatment. In following this plan some losses may occur during the first year or two unless noninfected pastures or fields are available to start with, but thereafter there should be no losses whatever.

This plan may be inaugurated at any time of the year. Supposing that it is to be begun just after lambing, say in March, it is advised that all of the sheep except the lambs be given a preliminary treatment with bluestone, coal-tar creosote, or gasoline, in accordance with the directions given in Circular 102 of the Bureau of Animal Industry. Any cattle or goats that may be on the farm must either be treated in the same manner as the sheep, being dosed for worms and moved from pasture to pasture in company with the sheep, or else be kept strictly apart from the latter in pastures of their own.

After the preliminary treatment, which will destroy a large proportion of the stomach worms that may be present, the sheep, lambs, and all other ruminants are removed to a pasture or field which may be termed pasture No. 1. Preferably this should be a pasture which is free from infection, but if such a pasture is not available, use an infected pasture, and some time in the summer, say the 1st of July, give the entire flock, lambs and all, another course of treatment and move them to a second pasture. The 1st of November another treatment for stomach worms is given, and the animals are moved to pasture No. 3, where they remain until the 1st of March. After this first year's treatment the medicine is given only in the fall, just before the sheep and cattle are moved to the pasture in which they spend the winter. On the 1st of March of the second year they are moved to pasture No. 4, then on the 1st of July to pasture No. 1, from which since July 1 of the preceding year all ruminants have been excluded, but which meanwhile may have been used if desired for live stock not subject to stomach worms, such as horses, mules, or hogs. November 1 the sheep and cattle, after being dosed for worms, are moved to pasture No. 2, from which, as in the case of pasture No. 1, all ruminants have been excluded since the corresponding date of the year before. Then in March pasture No. 3 is occupied again, and so on, from pasture to pasture in regular rotation.

By utilizing the pastures for other live stock during the periods that ruminants are excluded, the land included in the rotation scheme may be made use of more or less continuously. In lieu of some of the pastures, fields might be planted with suitable crops, and made to serve temporarily as pastures, and employed for other agricultural purposes, if desired, when not in use as pastures.

It is very probable, particularly in the case of badly infested flocks and farms, that the foregoing plan will at first fail to prevent entirely the loss of lambs from stomach worms. The flock should be watched closely, and if any of the lambs present symptoms of stomach

worms they should receive proper medicinal treatment. The pastures must not be heavily stocked, especially at first. The more numerous the sheep relative to the size of the pasture, the more heavily infested will the pasture become, and with close grazing the sheep are not only liable to pick up greater numbers of larval stomach worms, but also, unless auxiliary feeding is practiced, may not receive a sufficient quantity of food, and thus be less able to endure parasitic infection. As salt acts to a certain extent as a preventive against stomach worms, as well as being a necessary element in the diet of ruminants, it should be supplied to the sheep in liberal quantities. If possible the use of wet, low-lying pastures should be avoided, or this condition corrected by proper drainage.

The plan which has been outlined above may be variously modified. For example, in a climate with a cold winter season the same pasture could, if desired, be utilized every year as a winter pasture. The sheep would not be placed in this pasture until winter had set in, and would be removed again just before spring began. As already noted, any stomach-worm eggs passed in the feces of the sheep during the winter would either be killed immediately by exposure to freezing weather, or on account of the prevailing low temperature lie dormant or develop slowly with the practical certainty of being killed by freezing on some later occasion before they had reached the infectious stage. The order of rotation in this case would be as follows: Pasture No. 1 until July, pasture No. 2 until winter begins, then to pasture No. 3 (the winter pasture), then at the end of winter to pasture No. 4, then in July to pasture No. 1, then to the winter pasture (No. 3), then to pasture No. 2, etc.

FEEDING TOBACCO.

There has been considerable discussion recently in various live-stock and agricultural journals concerning the feeding of tobacco to sheep as a remedial measure against stomach worms. I will, therefore, in conclusion, briefly refer to some experimental work along this line conducted at the Experiment Station of this Bureau.

In June, 1908, a flock of sheep and lambs, in which stomach worms were known to be present, were separated into three lots with 5 lambs and 7 or 8 full-grown sheep in each, and placed in three similar small pastures. Lot 1 was fed leaf tobacco grown in Maryland, lot 2 tobacco cuttings obtained from a cigar factory, while lot 3 was fed no tobacco at all. Some difficulty was experienced in getting the sheep in lot 2 to eat the cuttings, and they finally had to be started on the leaf, afterwards changing to the cuttings, so that it was not until late in July that they really began to consume the cuttings. By the middle of August the sheep in each of lots 1 and 2 were consuming

10 ounces of tobacco every two days, an average per head of a little over two-thirds of an ounce every forty-eight hours. This represented the maximum which they would eat, and the feeding of this quantity every forty-eight hours was continued until early in December. There was no noticeable difference in the condition of the sheep in the three lots, which remained fairly good throughout the experiment. One lamb in the lot which was not fed tobacco died in July from unknown causes, no post-mortem examination being possible as the carcass was devoured by buzzards before the death of the animal was discovered. In the latter part of December and the early part of January the lambs and some of the ewes were killed and examined, with the result that stomach worms were found to be present in all three lots. In most cases there were only a few, but in one lamb several thousand stomach worms were found. Strangely enough this was a lamb from one of the lots which had been fed tobacco.

The conclusion reached in this experiment is that the feeding of tobacco had no noticeable effect either upon the stomach worms or upon the sheep. The results obtained can not be considered decisive, but they suggest the possibility that the favorable reports which have been made relative to tobacco as a remedy for stomach worms have been based on coincidences, the good results observed in such instances having been due to some other cause than the tobacco. In fact it has been noted that some sheep raisers who have tried tobacco have reported it a failure. At the present time, therefore, tobacco must be considered a remedy of doubtful efficiency so far as stomach worms are concerned.

[Cir. 157]



A. D. MELVIN, CHIEF OF BUREAU.

IMPROVED METHODS FOR THE PRODUCTION OF MARKET MILK BY ORDINARY DAIRIES.^a

By C. B. LANE, *Senior Dairyman*, and KARL E. PARKS, *Architect*,
Dairy Division.

The object of this article is to present in a simple way the various steps in the production, handling, and distribution of market milk, particularly from the standpoint of the small producer. No attempt will be made to describe the finer points applicable to a special product such as certified milk, but the object is rather to point out practical methods adapted to the ordinary dairyman. In view of the fact that the rules and regulations pertaining to the production of milk, as formulated by boards of health, both city and State, are requiring higher standards on the part of the dairymen, it is quite important that they should know how to meet them. Many dairymen would be glad to improve if they only knew how to go about it, but frequently they have nothing to guide them.

THE COWS.

The health of the cows is essential for the production of good milk. They should be in good physical condition and free from disease. They should also be tested for tuberculosis by a capable veterinarian at least once a year, and all reacting animals removed. The object of the tuberculin test is not only to safeguard the milk supply but to protect the herd from the ravages of this disease. The feed of the herd should be wholesome, and the water supply should be protected from contamination.

Dirt and dust adhering to the cows are responsible for most of the contamination of milk. It is therefore essential that the cows be clean—not necessarily washed every day and dried with a sterile towel, but clean in a common-sense meaning—that is, free from accumulation of dirt and manure, and thoroughly brushed. If the hair on the udders, flanks, and tails is clipped, this will aid in keeping the animals clean.

THE STABLE.

The stable should be free from contaminating surroundings and well drained. It should be constructed with a view to the comfort

^a Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry (1908).

of the cows and to keeping it clean with as little work as possible. Ledges, etc., which collect dust should be avoided. (See fig. 3.) Details of construction will not be discussed here, as that subject is covered in another publication. (Circular 131 of the Bureau of Animal Industry.) It may be said, however, that the floors and gutters should be tight and preferably constructed of concrete. The walls and ceilings should also be tight. Some form of swing stanchion will give the cows plenty of freedom and keep them lined up on the gutter. The mangers should be low. When practicable the stalls should be constructed of metal piping (see fig. 9), exposing the

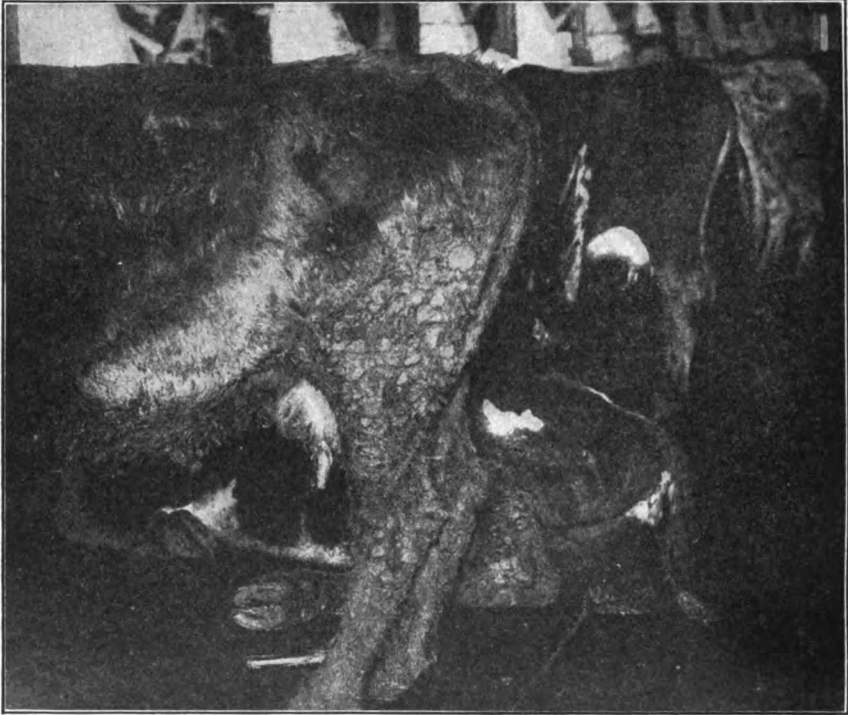


FIG. 1.—Cows in filthy condition. It is impossible to produce clean milk under such conditions.

least possible surface for collecting dust and allowing free circulation of air. An abundance of light is very important; 4 square feet of glass to each cow will be found about right. About 500 cubic feet of air space should be provided for each animal.

A system of ventilation should be provided that will keep the air fresh and pure at all times. The King system^a has been found very satisfactory. Its essential features are several inlet flues to admit and distribute fresh air and one or more outlet flues of adequate size

^a The King system of ventilation is described in Bulletin 164 of the Wisconsin Agricultural Experiment Station.

to assure rapid removal of foul air. Where it is not practicable to install the King system, the muslin-curtain system will be of some benefit. This consists of pieces of muslin nailed over openings in the walls at suitable places. The grade of muslin known as "Four and one-half" is about the right quality. Adjustable windows are better than no ventilation.

The most common defect in dairy stables is lack of cleanliness. Cobwebs and manure on walls and ceiling are met with in every section of the country. The dairyman should see to it that this criticism can not be made of his stable. A coat of whitewash twice a year will



FIG. 2.—Clean cows in a clean, comfortable stable. The cows are supplied with plenty of bedding.

make the stable lighter and the air sweeter and will destroy countless germs. No other animals than the cows should be allowed in the stable. The barnyard should be well drained and free from manure and rubbish. The manure should be removed at least twice daily to the field or a safe distance from the barn, say, 40 or 50 feet. Manure about the stable breeds flies and gives off bad odors.

THE MILK HOUSE.

The milk house should be located at a convenient place where there is good drainage, and should be free from contaminating surround-

ings. A cement floor is very important, and this should be extended up on the sides at least 6 inches, or, better still, to the window casings, particularly in the wash room. Light and ventilation should be provided, and the windows and doors should be screened in summer. Cleanliness is of great importance here, and the whole interior, including floor, walls, ceiling, and windows, should be kept clean.

PLAN FOR A MILK HOUSE.^a

The building illustrated in figures 5 and 6 is designed to provide an inexpensive and conveniently arranged milk house for the



FIG. 3.—An undesirable stable. Note cobwebs heavily laden with dust, and wooden construction, which collects dirt and requires much labor to keep clean.

dairyman who produces milk for shipping or retailing from a herd of 25 to 60 cows. The building is divided into four rooms, arranged to eliminate unnecessary labor and at the same time to provide sufficient space for the apparatus, its operation and care. The best location for the milk house would be about halfway down the length of

^a Persons desiring to build a milk house according to this plan may obtain a blueprint showing details of construction on application to the Dairy Division, Bureau of Animal Industry, Department of Agriculture, Washington, D. C. Refer to plan H-2.

the barn and 12 to 15 feet distant from it. A door in the side of the barn at this point, opening from a cross alley, makes it convenient for the milkers and saves unnecessary time and travel. A driveway should be placed between barn and milk house for bringing empty cans, bottles, fuel, ice, etc., to the milk house, and for loading milk upon the delivery wagon.

In one corner of the building a small weigh room is partitioned off, the floor of which is raised 24 inches above the main floor; this room is entered from the vestibule. The milker takes the milk of each cow to this room, where it is weighed, recorded on the milk sheet,



FIG. 4.—An insanitary milk room. The family washing is being done in the same tubs in which the milk cans and utensils are washed. Part of the clothes are hanging on the milk-can rack to dry, and piles of soiled clothes, boots, shoes, etc., are scattered around the floor. These conditions favor the spread of contagious diseases through milk.

and emptied through the funnel (A), which is provided with cheese-cloth strainers and a hinged cover. The milk passes from the funnel by gravity to a mixing tank and cooler (B), from which it empties into a can which is carried over to the bottle filler (C) for immediate bottling, or into shipping cans which may be placed in the pool built into the bottom of a refrigerator (E). If it is desired to separate the cream, a steam turbine separator would be provided at N, run by steam from the boiler. It will be observed that the milk room is so located that it is not necessary to enter it except to care for the milk, thus making it easy to keep clean and cool and free from flies, dust, and other contamination.

The bottled and canned milk is placed in the refrigerator (D) until time for shipment, when it is loaded from the vestibule to the wagon. The refrigerator is built into the building, with ice storage overhead, which is filled through a door from the outside, directly from the wagon. The pool in the floor is supplied with spring water by a ram or other means, and is provided with an overflow to maintain a certain height of water. The melting ice drips into the pool, which also tends to keep the temperature of the water low.

A door from the rear gives access to the boiler room and the wash room, and through this door empty bottles and cans are returned from the wagon for cleansing. The wash room is provided with a

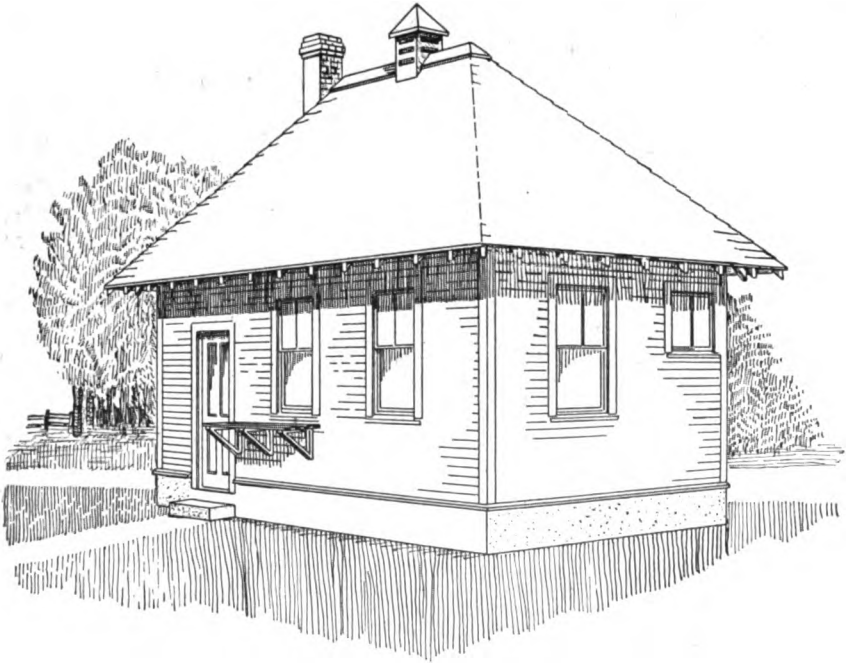


FIG. 5.—A practical and inexpensive milk house for a dairy of 25 to 60 cows.

two-compartment concrete sink, the larger compartment (I) for washing cans and bottles with soapy water, and the smaller (H) having a revolving brush for brushing and rinsing the bottles in clear water. After the bottles are washed they are placed in galvanized iron bottle carriers in an inverted position and the carriers are placed in the sterilizer (F) on runs provided for them. The sterilizer as shown (fig. 7) will hold 240 1-quart bottles. Below the bottles in the sterilizer is a space for sterilizing cans, pails, and other apparatus, so that all may be sterilized at one time and left in the sterilizer until they are to be used, which keeps them sterile and free from contamination. Sterilization is accomplished by turning in

steam for not less than thirty minutes (low pressure). A door from the sterilizer to the milk room is provided so that the bottles may be conveniently taken from the sterilizer, and placed on the bottle-filler table for filling.

The wash room also has an outside door, giving access to a sunning rack for sunning pails, cans, etc. There should be no driveway in front of the building, as this causes a great deal of dust and dirt, which blows over the sunning rack and in at the windows and doors. In the wash room is also provided a table and a Babcock tester (G) for testing samples of milk. The boiler room contains a small farm boiler which provides steam for sterilizer, separator, and bottle filler and hot water for sinks.

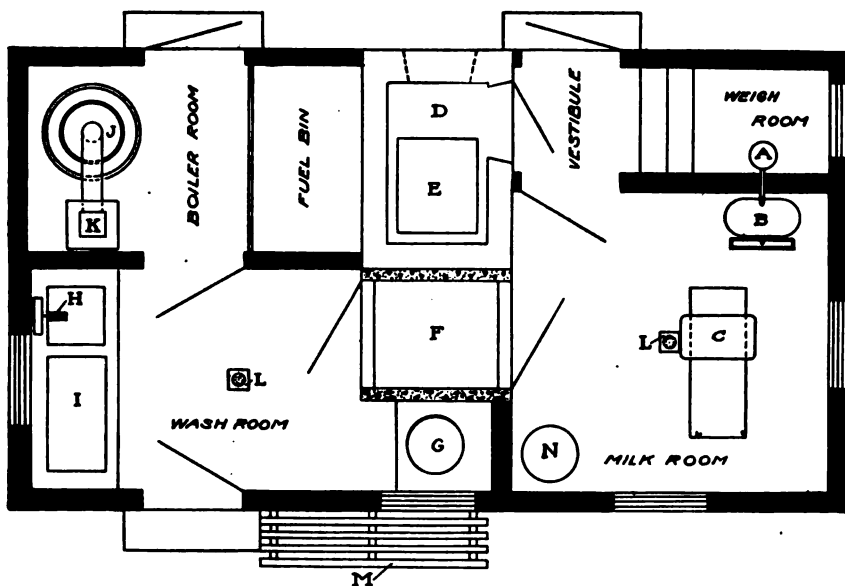


FIG. 6.—Floor plan of milk house shown in Fig. 5. A, receiving funnel; B, milk cooler; C, bottle filler; D, refrigerator; E, cooling tank; F, sterilizer; G, Babcock tester; H, bottle washer; I, concrete sink; J, boiler; K, chimney; L, floor drains; M, sunning rack; N, separator.

If it is desired to cool the refrigerator with a brine tank a small engine and ice machine could be placed in the space allowed on the plan for a fuel bin, with condenser placed on the refrigerator wall, and fuel bin built just outside boiler-room door.

The building itself is 12 by 22 feet outside the frame, and height of story is 11 feet 2 inches in the clear. It is a light frame structure placed on a concrete foundation built 18 inches above ground, and has a concrete floor 6 inches below top of foundation wall. This brings the sills above the floor, so they will not rot from the dampness, as the floors should be washed daily.

The exterior of the building is covered with weatherboarding, boards and battens, or roofing paper, as desired, while the interior is plastered in weigh room, milk room, and wash room with cement plaster on metal lathing and finished in white enamel paint. The walls are plastered against door and window frames, and casings omitted. All corners are plastered round and smooth to avoid lodging places for dirt and germs. Ventilator flues from the ceiling of milk and wash rooms are connected with the monitor on the roof. The boiler room is left unfinished except on wash-room partition, which is sheathed to protect plaster on wash-room side.

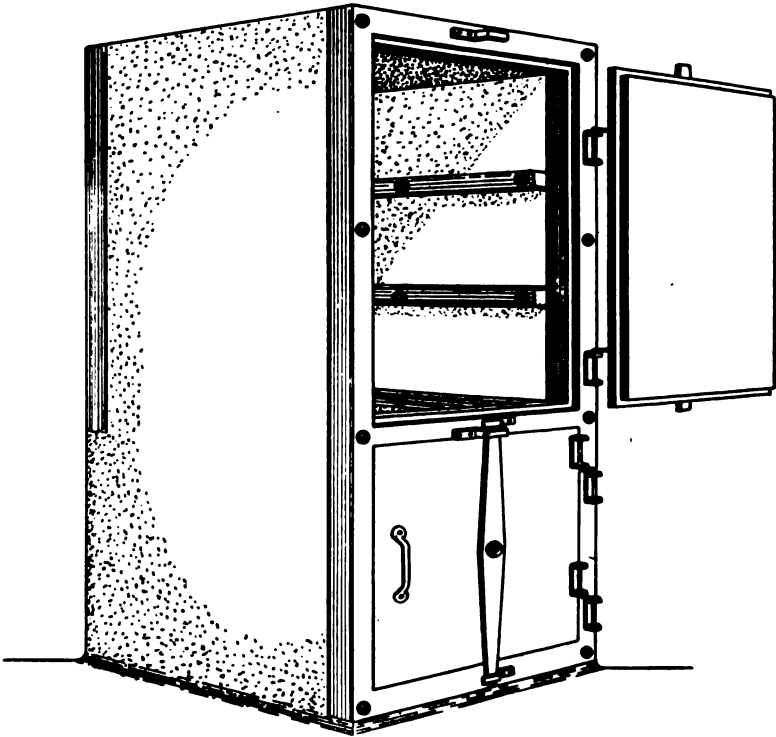


FIG. 7.—Sterilizer for milk bottles, cans, etc.

The building should be built for from \$200 to \$400, according to location, cost of material, labor, etc.

UTENSILS AND EQUIPMENT.

The utensils are a very important part of the dairyman's equipment. The cans and pails should be well built, with seams well flushed with solder, or, better still, no seams at all. All utensils require the most careful attention in regard to cleaning and sterilizing. They should be thoroughly washed and subjected to live steam or boiling water, then inverted in pure air. The kitchen stove rarely

answers the purpose for heating water for the reason that the amount so heated is usually limited, and by the time it is taken to the place where the washing is done it has become too cool to have any effect as a sterilizing agent. A large hot-water tank or a boiler is necessary for the purpose. It is important that the water used in cleaning be pure, as contagious diseases have frequently originated from water used in washing.

Some form of small-top or covered milk pail is very important in milking (see figs. 8 and 11). Figure 8 illustrates the advantage of the covered pail over the ordinary open pail in keeping dirt out of the milk. W. A. Stocking, jr., made tests with open and covered pails in a stable where but little care was given to cleanliness, and found that milk drawn in the open pail contained an average of

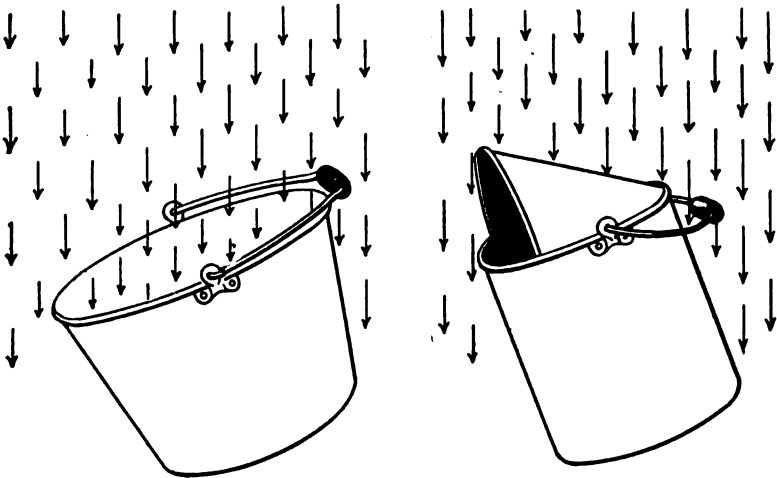


FIG. 8.—Two kinds of milk pails. The open pail admits much dirt; the covered pail keeps it out.

3,439,200 bacteria per cubic centimeter, while that drawn in the covered pail contained an average of only 103,600.

A metal stool for milking is more desirable than a wooden one. It is less cumbersome and far more sanitary.

A milk cooler is another important part of the dairyman's equipment, unless the milk is drawn directly into the shipping can (as in fig. 11). The cooler must be kept clean and not located near the stable.

A cheap but practical sterilizer for a small dairyman is shown in figure 7. It is constructed of concrete, reenforced with metal lathing, and fitted with wooden doors lined with galvanized iron. The open door shows the runs on which the carriers are placed. Each space accommodates 5 carriers holding 16 one-quart bottles each. This sterilizer will cost from \$30 to \$50, depending upon the price of material and labor.

MILKING.

The milker should prepare himself for milking to the extent of putting on a special suit or outer garment. A big apron used by some dairymen is better than nothing. The milk should be drawn with clean, dry hands. The cows having previously been cleaned, the udders and flanks should be wiped with a moist cloth preparatory to milking, or, better still, washed and thoroughly dried.

In experiments made by Stocking, only 716 bacteria per cubic-centimeter were found in milk drawn after udders and flanks of cows had been wiped with a damp cloth, while 7,058 bacteria per cubic



FIG. 9.—Milking cows under clean and sanitary conditions.

centimeter were found in milk from cows not so wiped before milking. It is important that the air in the stable be free from dust and odors during milking.

HANDLING THE MILK.

The milk should be removed from the stable after each cow is milked, and cooled immediately to a temperature below 50° F., if possible. If not convenient to cool the milk until a can is filled, it should at least be removed from the stable and not allowed to stand exposed to the stable air. The quicker it is cooled the longer it will keep sweet.

The importance of promptly cooling milk is well shown by figure 10, based on experiment by Prof. H. W. Conn, of the Storrs (Connecticut) Agricultural Experiment Station. It appears that the

multiplication of bacteria in twenty-four hours in milk kept at 50° F. was only fivefold, while at 70° F. it was seven hundred and fifty fold.

The steps in handling the milk, as already given in connection with the description of a milk house, may be summarized as follows: The milk is taken up into the weigh room and poured into the strainer (A), through which it passes into the mixing tank, then falls by gravity over the cooler (B) and is transferred to the bottle filler (C). After being bottled it is stored in the refrigerator (D), or, if held in cans, it is stored in the tank (E).

STORAGE AND TRANSPORTATION.

Milk should be stored preferably at a temperature below 50° F. This means that ice should be used. Spring water at a temperature not exceeding 55° F. will give fairly good results, provided the cooling is done immediately and there is a good flow of water in the spring where the milk is stored. It is desirable to use cracked ice in transporting the milk in summer, either on the retail wagon or to the station for shipment. If this is impossible, a jacket or wet blanket over the cans will aid in keeping the milk cool.



FIG. 10.—Effect of temperature upon growth of bacteria. *a*, A single bacterium; *b*, its progeny in twenty-four hours in milk kept at 50° F. (5 bacteria); *c*, its progeny in twenty-four hours in milk kept at 70° F. (750 bacteria). (From Bulletin 28, Storrs (Conn.) Agricultural Experiment Station.)

A DEVICE FOR MILKING DIRECTLY INTO THE SHIPPING CAN.

The every-day work of the dairyman should be made as simple as possible. The fewer the operations the less work and the less danger of contamination. Realizing the importance of saving time in dairy work, Dr. Lee H. P. Maynard, of the Dairy Division, has devised a combination milk pail, can, strainer, and stool (see fig. 11).^a This plan does away with the milk cooler that is usually considered a necessity in the dairy. A funnel is placed in an opening made in the shoulder of a 5-gallon can, of the type that has a cover which screws in air-tight; a piece of cheesecloth is held in the funnel by means of a metal spring, and the milk can slides into a metal frame which is

^a Application has been made for United States patent on this device under the act of Congress of March 3, 1883, so that the device may be used by the Government of the United States, or any of its officers or employees in the prosecution of work for the United States, or by any person in the United States, without the payment of royalty.

used as a stool and so constructed that the can may be adjusted to any height to suit the convenience of the milker. When the can is full all the milker has to do is to remove the funnel, screw a cap into the opening, and place the can in the storage tank. The funnel is simply washed and boiled and set away in a tin receptacle kept specially for the purpose. It is all the apparatus the dairyman has to clean if



FIG. 11.—The Maynard combination milk pail, can, strainer, and stool. This simple device makes it possible to produce clean milk in almost any stable.

the cans are properly sterilized by the dealer. When we compare this simple apparatus with the ordinary open milk pail and wire-gauze strainer, wooden milk stool, a milk cooler (which as ordinarily kept inoculates the milk with countless bacteria), and a 10-gallon can, we find the handling of milk much simplified.

We do not wish to give the impression that the cooling and aerating of milk as ordinarily practiced is not important, since it is well known that the keeping quality of such milk

is much improved by running it promptly over a tubular cooler, provided the cooler and surrounding air are clean. Where the Maynard pail is used, however; cooling and aerating by means of a tubular cooler are not necessary, for the reason that there are but few germs to multiply and no cow-stable odors to be removed; hence cooling in the shipping can answers all requirements and is much simpler and quicker.



636.073
u58
B95c

GENERAL LIBRARY
UNIV. OF MICH.
APR 21 1910

Issued March 16, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 159.

A. D. MELVIN, CHIEF OF BUREAU.

SOME IMPORTANT FACTS IN THE LIFE HISTORY OF THE GID PARASITE AND THEIR BEARING ON THE PREVENTION OF THE DISEASE.

By MAURICE C. HALL,
Junior Zoologist, Zoological Division.

It appears from correspondence received by the Bureau of Animal Industry that considerable doubt exists in those sections of the country where gid is prevalent as to the correctness of the generally accepted life history of the gid parasite. These doubts are harbored by veterinarians and by sheepmen, the persons on whom the prophylaxis of gid depends, and if disbelief on their part is followed by a disregard for those measures on which the prevention of gid depends, a continuation and spread of the disease may be confidently expected.

The life history of the gid parasite is essentially as follows: The adult parasite, a tapeworm, develops in the small intestine of the dog, and on attaining sexual maturity produces thousands of small eggs which are contained in the posterior segments. These segments are passed with the feces usually; perhaps at times single segments or chains of segments escape or are expelled without feces, and under proper conditions of temperature and moisture these rot and liberate the eggs. Such eggs as in this way attain a favorable location on herbage where sheep are pastured, or in water which sheep drink, may be taken into the digestive tract of the sheep with food or water, the hard shell digested off, and a minute embryo liberated. This embryo bores its way through the walls of the digestive tract by means of the six hooks with which it is armed, and apparently bores finally into a blood vessel, along which it is swept with the blood current until it lodges. It may develop at this point, or it may

start an active migration through the tissue in which it lodges and start to develop after traversing a short space. In the brain and spinal cord the embryo grows into a larval cestode known as a bladder-worm, consisting of a membranous sac on which numerous tapeworm heads develop. In all other situations the embryo starts to grow, but almost invariably degenerates and dies in a short time. If the bladder-worm in the brain or spinal cord is ultimately eaten by a dog, the sac will be digested but the tapeworm heads will pass unharmed to the intestine, where they will gradually develop segments until each head has formed a complete tapeworm ready to reinfect the food and drink of sheep.

This life history of the gid parasite is not at all a matter of speculation and rests upon no uncertain basis. It was first completely demonstrated by Küchenmeister (1853e)^a by feeding the brain bladder-worm from the sheep to the dog, and eggs from the dog tapeworm to the sheep, and it has since been confirmed in numerous cases by workers in Germany, France, Italy, England, and Scotland, and by Ransom and the writer in the United States. The larval parasite is commonly recorded from sheep which have not been the subject of experiments, but can be produced at will by feeding the eggs of the adult tapeworm. The adult worm is commonly recorded as produced by feeding experiments, but has been often recorded as found in dogs not the subject of such experiments. Additional proof of the correctness of our knowledge of the life history has been furnished by a number of observations, such as those of Heitzmann (1868a), where the duration of gid in a given flock has been coextensive with the employment of dogs infected with tapeworms, and the cessation or diminution in extent of the disease has coincided with the removal of these dogs or their treatment for and removal of the tapeworms.

The objections which have been raised to the life history as given are that it is improbable that dogs could get at the brain through the skull of giddy sheep, and that in actual practice they do not do so. At first thought the argument that a dog could not get at the brain of a giddy sheep seems very plausible—in spite of the fact that we are accustomed to see a dog crush the femur of an ox to get at the bone marrow—and the statement of a reputable veterinarian in Montana that according to his observation such would be an extremely exceptional case, and that sheepmen of long experience are unanimous in the opinion that dogs do not at any time eat the brains of sheep, lends additional weight to this argument.

^a For a complete reference to this article and to other articles by various authors cited in the present paper the reader is referred to Bureau of Animal Industry Bulletin 39, Index-Catalogue of Medical and Veterinary Zoology.

[Cir. 159]

The argument that the brain of sheep is practically inaccessible to dogs is not a new one. Five years after Küchenmeister (1853e) had demonstrated the life history of the gid parasite, Reynal (1858a) states that in those countries where gid is prevalent the sight of a dog eating the heads or the brains of sheep dead of gid is not so common as one might believe. He further urges that it is difficult for him to believe that the gid parasite, protected by a bony case and located in an organ which decomposes readily, could be eaten in the great majority of cases.

It is evident that since one *cœnurus* will supply a dog with a large number of tapeworms, only a small proportion of the infected sheep heads needs to be eaten in any given season in order to keep up the infection.

Aside from this, if the objections to the dog's ability to eat sheep heads are sustained, the two obvious alternatives are that the brains are removed from the skull by people and either the brain containing the parasite or the parasite itself fed to dogs or thrown where dogs and other carnivora have access to them, or, as has been suggested to the Bureau in correspondence, that the *cœnurus* develops in the body of the sheep outside of the brain and spinal cord as well as in these locations.

Küchenmeister (1853e) found on investigation in Germany that some people were accustomed to taking out the brains of giddy sheep and feeding them to the dogs, and Heitzmann (1868a) notes instances where the *cœnurus* itself was extracted from the brain and fed to the dogs. It would not be surprising to learn that sheep owners or herders in this country had made this same mistake. Evidence is not wanting to show that these customs have not yet disappeared from Germany after more than half a century of education on this subject, and gid as an economic problem is of comparatively recent date in this country.

That the gid parasite should develop in the sheep outside of the central nervous system to the point where it would be capable of infecting the dog, and that helminthologists should be unaware of it, is altogether out of the question. In all of the numerous experimental demonstrations of the life history made in this country and abroad, the parasites recovered by careful post-mortem examination of the parts outside of the central nervous system of the sheep have always been found aborted. The parasites of few, if any, animals have been studied more than those of the sheep, and the gid parasite especially has received a great deal of attention. The idea that well-developed *cœnurus* forms should occur outside of the central nervous system with such frequency as the objections call for, and go undetected in abattoir inspection and post-mortem inspection of other sorts, is not

in the least tenable. The extensive literature of gid available in Washington shows that the occurrence of a *cœnurus*, said to be the gid parasite, in subcutaneous situations in sheep has been claimed once by Eichler (see Leisering 1859a) and once by Von Nathusius (see Leisering 1862a), the occurrence of *cœnuri* of the same species in the thyroid, lymph glands, and musculature of *Hippotragus equinus* has been claimed once by Rabe (1889a), and a very doubtful case of a *cœnurus*, stated as probably *Cœnurus serialis*, from a subcutaneous situation in a horse in the United States, is noted by Stiles (1898a). Such cases are extremely exceptional and can be disregarded as negligible quantities in the prophylaxis of gid.

It is interesting to note that in the available literature there is no definite record of any observations on the eating of sheep heads by dogs. That they do so seems to be taken for granted or perhaps regarded as too well known or too self-evident to need demonstration or proof. And it is possible that on the European farms, where the flocks have smaller ranges and are more closely and carefully watched than is the case in our Western States, the facts in this case are well known. As has been stated, the fact that dogs will eat sheep heads does not seem to be generally appreciated in this country. The veterinarian to whom we have referred writes:

In driving around over sheep ranches it is a common sight to see hundreds of sheep skulls lying around the pens, and it is rare indeed to find one where the bony structure has been broken sufficiently to permit the eating of the brain by the dog or coyote.

This sentence indicates the existence on sheep ranches of a condition extremely favorable to the spread of gid, and expresses by inference a belief, accompanied by an apparent justification, that prophylactic measures to prevent dogs and wolves from eating sheep heads are not well founded.

In view of this, the writer undertook an experiment looking toward answering the question as to whether dogs eat sheep brains when these are protected by the skull. A dog, part collie in breed and weighing 25 pounds, was fed the head of a 10-month-old lamb on the morning of December 3, 1909. In order to expedite matters the head was skinned and the eyes and tongue removed. The next morning the dog had eaten the nose back to the nasal bones, broken off the jaws, licked the eye orbits, and had cracked off a piece of bone the size of a quarter (about 2.5 cm. in diameter) from the base of the skull adjacent to the foramen magnum, thereby exposing the base of the cerebellum. In doing this, what there was of the spinal cord, together with the medulla oblongata, had been eaten, but the cerebellum had not been touched. The skull was taken from the dog and left in the ice chest at a temperature of 10° to 15° C. for

[Cir. 159]

five hours, when it was again fed to the dog. The next morning all that remained of the skull were two small pieces of bone, one being the back part of one lower jawbone, and the other the back part of the two upper jawbones with a part of the palatine connection between them. The rest of the skull and all of the brain and muscles had been eaten.

The evening of this same day, December 6, the head of another 10-month-old lamb was fed to the dog, the head being skinned and the tongue removed. The next morning it had hardly been touched. It was put on ice till evening and fed again. The next morning the head seemed on first sight untouched. Examination showed, however, that the dog had cracked off a small piece of bone from the foramen magnum forward to near the posterior root of the zygomatic arch, and with this comparatively small opening had licked out the entire brain with his tongue. The rest of the skull and the meat were untouched. From his experience with one sheep head the dog had developed a preference for sheep brains and had hit upon a method for getting them through a very small opening in the skull.

We may safely apply these experimental findings to field conditions. The dog used in the experiment was a common stray dog which had been picked up in Nevada and shipped here in connection with an experiment. The breed was well suited to the purpose of this experiment, and the size of the dog was no greater than that of western sheep dogs. The lambs were of suitable age, as sheep are usually subjects of gid during the first year of life—a time, be it noted, when the skulls are not as thick as they become later. The fact that the sheep head was skinned and the tongue, or the tongue and eyes, removed, merely served to hasten matters, but not to alter sensibly the bearing of the experiment on the question at issue. The absence of a cœnurus from the brains used gives additional weight to the experiment, if anything. The dog used had previously been fed several cœnuri of a species related to the gid parasite and had apparently relished them, and this is in line with the experience of other experimenters. Moreover, the presence of a cœnurus is very commonly accompanied by a thinning or perforation of the bone over the parasite, and this would make the brain more, and not less, accessible. Numan (1850b) has noted the skull of a giddy sheep with 22 such perforations. Such a skull would be easily crushed.

The reasonable conclusion from the experiment is that dogs have both the inclination and the ability to eat the sheep brain even when the brain is protected by the skull. The difficulty of getting at the brain is not extreme, but only supposedly so.

The casual observer, seeing on the range such remnants as were left of these two sheep heads, either just as the dog left them or as

[Cir. 189]

they would look six months later, would never surmise that a dog had eaten the brains. There was too little of the first skull and too much of the second to suggest this. Unsupported by experimental evidence, the suggestion that a dog would lick out a brain through a slight enlargement of the foramen magnum might seem rather far-fetched.

The experiment suggests that the reason sheep skulls showing evidences of having been broken into by carnivorous animals, are not seen on ranches is that dogs and perhaps other animals which prefer to feed in seclusion might unobserved reduce sheep heads to such small dimensions that the remaining portions would be overlooked or not connected with the eating of the brains by carnivora. It seems likely that a taste for sheep brains would be developed, and that carnivorous animals might commonly employ a scheme for getting at the brain similar to that utilized by the dog in the experiment. The dog used in this experiment was not very hungry. He had been well fed previous to the experiment, and the sheep heads simply replaced his accustomed meals.

The opinion has been expressed by correspondents that precautions to prevent dogs or wolves from eating the heads of dead sheep would be unnecessary in the winter time in States like Montana, where the disease is prevalent, on the assumption that the gid parasite would be promptly frozen and killed. It is true, as Perroncito (1885b) has shown, that freezing will kill the gid parasite. On the other hand, the protection afforded by the brain, the skull, and the skin, and the retained animal warmth would insure against immediate freezing even in very cold weather. Furthermore, the nature of the gid disease is such that giddy sheep must contribute a large percentage to the number of strays which fail to return because they have fallen a prey to dogs or other carnivora and have been eaten before freezing could possibly be a factor in the case. As a matter of fact, the fully developed gid parasite, capable of infecting the dog, is most common in spring when the weather is milder.

In this connection it should be noted that the dog is the only host in which the adult gid parasite is positively known to occur. It has never been found among the coyote tapeworms from Montana examined at this laboratory. However, very few coyote tapeworms have been examined, and it is quite probable that not only coyotes, but other wolves and foxes also, none of which have ever been definitely proved to be a host of the gid parasite, may nevertheless harbor this tapeworm. It would be no mistake to kill these animals as possible carriers of gid, as well as on other grounds, and the useless, ownerless dogs should be put in the same category. Incidentally, it would be advisable to bury such dead carnivora to avoid infecting pastures

from the decomposing intestines, a possibility suggested by Küchenmeister (1853e).

In conclusion, the prophylaxis advocated in the previous publications of the Bureau of Animal Industry by Curtice (1890c), Stiles (1898a), and Ransom (1905d) should be rigorously adhered to. This prophylaxis, based on the life history as given, consists essentially in interrupting the cycle of the parasite's development at the points where it is most easily attacked. In practice, this consists in the destruction of the gid parasite from the brains of sheep dying of gid and in allowing on the pasture only such dogs as are necessary, and keeping these free of tapeworms. The parasite in the brain is best destroyed by burning, or if the heads are needed as food for the dogs, they should be subjected to prolonged boiling. Buried heads are liable to be dug up. As the adult tapeworm develops in the dog in four to eight weeks as a rule, the utmost precaution would demand vermifuge treatment every month or two. In practice it seems probable that routine vermifuge treatment four times a year, and oftener when it was evident that a dog was infected, would eliminate the disease, especially if particular care were taken to free the dogs of worms in the spring when the outbreak for the year is over and there are no more giddy sheep heads available.

A discussion of other prophylactic measures is reserved for a future time, when field studies and experiments have shown their applicability to the local conditions involved.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *February 9, 1910.*

[Cir. 159]



36.073
258

Issued March 21, 1910.

B95 U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY—CIRCULAR 160.
A. D. MELVIN, CHIEF OF BUREAU.

APR 21 1910

LIP-AND-LEG ULCERATION OF SHEEP.

I. THE WORK OF THE BUREAU OF ANIMAL INDUSTRY FOR THE SUPPRESSION OF LIP-AND-LEG ULCERA- TION OF SHEEP.

BY

A. D. MELVIN, D. V. S.,
Chief of the Bureau of Animal Industry

II. LIP-AND-LEG ULCERATION (NECROBACILLOSIS) OF SHEEP: ITS CAUSE AND TREATMENT.

BY

JOHN R. MOHLER, V. M. D.,
Chief of the Pathological Division.



WASHINGTON :
GOVERNMENT PRINTING OFFICE.
1910.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY,
and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., February 21, 1910.

SIR: I have the honor to transmit herewith two papers, dealing with the disease known as lip-and-leg ulceration of sheep, which were presented respectively by myself and Dr. John R. Mohler, Chief of the Pathological Division of this Bureau, before the convention of the National Wool Growers' Association at Ogden, Utah, January 8, 1910.

As this disease has become so serious in some localities in the West as to necessitate a federal quarantine, and as these papers contain information which will enable sheep raisers to apply measures of prevention and treatment, I respectfully recommend that they be published together as a circular of this Bureau.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

LIP-AND-LEG ULCERATION OF SHEEP.

I. THE WORK OF THE BUREAU OF ANIMAL INDUSTRY FOR THE SUPPRESSION OF LIP-AND-LEG ULCERATION OF SHEEP.

By A. D. MELVIN,
Chief of the Bureau of Animal Industry.

For many years there have existed in the United States a group of diseases of an ulcerative nature affecting animals of various species and attacking various parts of the body. These affections, which have been known by such names as foot-rot, necrotic dermatitis (or inflammation of the skin), necrotic stomatitis (or sore mouth), and other terms, have been found by scientific investigation to be due to one and the same germ, known as the necrosis bacillus; consequently they have been grouped under the general designation of necrobacillosis, and may be considered as a single disease manifesting itself in various forms.

The Bureau of Animal Industry had occasion to study this disease as long ago as 1902, and during the period since that year it has made careful investigations and studies of various forms occurring in different species of animals. An article on foot-rot of sheep and another dealing in general with the necrosis bacillus were published in the Bureau's annual report for 1904, and a bulletin was issued in 1905 with special reference to the forms known as calf diphtheria and sore mouth in pigs. In 1906 an importation of Swiss goats was found affected with a disease which it was at first feared might be foot-and-mouth disease but which proved on investigation to be necrobacillosis, and an opportunity was thus afforded for a study of the disease at that time.

Until recently the nature of the disease in the United States in most instances has been mild, but within the past year or two it has assumed a malignant form among sheep in Wyoming, Montana, and some of the other Western States, where it has especially affected the lips and legs of the animals (and in many cases the genital organs), and has received the name of lip-and-leg ulceration.

It is my purpose at this time to discuss the nature of the disease only in a general way, and to discuss more especially the situation in

the Western States during the past year or more and the steps taken by the Bureau of Animal Industry to suppress the disease. The technical side of the subject is presented in the accompanying paper by Dr. John R. Mohler, chief of the Pathological Division of the Bureau.

The first information received by the Department of Agriculture indicating the serious character that the disease had assumed among sheep in the Northwest was conveyed in a telegram of November 23, 1908, in which it was stated that there was a serious outbreak of what was called foot-and-mouth disease in three counties of Wyoming, and asking that the Bureau send an expert to make an investigation so that proper steps might be taken to deal with the trouble. This report, coming at a time when we were engaged in combating an outbreak of foot-and-mouth disease in the East, and when it was not known how far the contagion of that disease might have spread, caused grave apprehension that foot-and-mouth disease might have reached the range country of the West, where it would have been a much more difficult and serious problem. I therefore took immediate steps to have the disease in Wyoming investigated, and within a week reports had been received from two of our inspectors, Drs. R. H. Treacy and E. J. Cary, to the effect that the disease was of a necrotic nature and not foot-and-mouth disease. It is hardly necessary to add that this information was very gratifying and relieved the fear that had been felt.

It appeared, however, that the disease affecting sheep in Wyoming was really a serious matter, so a number of additional men were sent by the Bureau to examine flocks at different places and to make a careful and thorough examination and study of the disease. Large numbers of specimens were sent to the pathological laboratory at Washington and were there examined by scientific methods that could not be used in the field.

The result of these further investigations confirmed the diagnosis already made and left no doubt that the disease was a malignant form of necrobacillosis. Attention was then directed to the study of methods of treatment, and steps were taken to disseminate information as to the character of the disease and the measures that should be taken to cure it and prevent its spread.

In the early period of the outbreak the Department recommended that affected animals be segregated and given careful treatment by hand with proper disinfectants. This seemed to most sheep owners to be an impossible method of procedure, on account of the large number of animals affected and probably also because such treatment was so different from and so much more difficult than any method that they had ever before been obliged to use in handling their sheep. It should be understood that at this time there had been no work

done looking to the treatment of large bands of sheep running upon the open range. The next expedient resorted to in this emergency was the dipping in an antiseptic solution of the exposed sheep and those but slightly affected, with the expectation that this might check the disease and cure these slight cases. This treatment, however, seems in many instances not to have met with the success that was expected of it, and to-day owners are returning to the hand treatment of all affected sheep, as originally proposed by the Bureau. The failure of dipping to give satisfactory results in all cases was probably because some sheep were actually infected before dipping and because in some cases the disease was contracted after dipping by the animals being placed in infected corrals, pens, or cars, or being driven over infected trails.

At first it was hoped that as the affected territory was limited the outbreak might be suppressed by local measures without the necessity of resorting to federal quarantine. Furthermore, the Bureau at this time had not finished its work of eradicating foot-and-mouth disease in the East and was in no position to spare either the men or the money to take up in a vigorous way the suppression of lip-and-leg ulceration in the West. As the time went on, however, and the malignant form of necrobacillosis continued to spread, it was considered best to declare a federal quarantine on sheep in eight counties in Wyoming, and this was done by the Secretary of Agriculture on August 6, 1909, to take effect August 12. This action was taken only after conference with the authorities of Wyoming and other States, and after receiving requests from those officers and from numerous sheepmen that the Bureau do what it could to check and eradicate the disease.

During the month of August, while Secretary Wilson was on a trip of observation of the Department's work in the West, he was appealed to by some of the sheepmen at Rawlins, Wyo., and he directed that I confer with them later and render whatever assistance the Bureau could give in an effort to control and eradicate the disease. A meeting was therefore held at Cheyenne on August 30, which was attended by a large number of prominent sheep raisers, and by the governor, the state board of sheep commissioners, and representatives of the state wool growers' association, as well as by several representatives of the Bureau of Animal Industry. The situation was discussed very fully as far as it was understood at that time, with reference to the best methods of combating the disease. At that time the Bureau representatives had not completed their investigations as to methods of treatment, which they had commenced only a few months before.

Following this conference another meeting was held, at which the state board of sheep commissioners, representatives of the state wool growers' association, and representatives of the Bureau of Animal

Industry were present, and a draft of the Wyoming Order No. 29 was tentatively decided upon.

As a result of these meetings, and at the request of the sheep owners, the Bureau undertook to assist in carrying out the order requiring dipping and the hand treatment of affected sheep, which at that time was thought to be the most expeditious method of dealing with the disease.

The first federal quarantine order, which took effect August 12, prohibited the interstate movement from the quarantined area of sheep affected with lip-and-leg ulceration. It permitted the interstate shipment of exposed sheep to recognized slaughtering centers for immediate slaughter without dipping, but required the dipping of exposed sheep for interstate shipment for stocking or feeding purposes. Healthy unexposed sheep were allowed to be moved interstate from the quarantined area when accompanied by a certificate of inspection by the Bureau of Animal Industry. The quarantined area was slightly changed at the request of the Wyoming board by an amendment effective September 15.

On November 22 the terms of the quarantine were somewhat altered so as to provide for a reinspection in less than seven days after inspection and dipping, and if necessary a second dipping, of sheep not diseased but which were a part of a diseased band, before they could be moved interstate for breeding purposes, and also to provide that the state or territorial officials should assume the responsibility of permitting exposed sheep to be moved without dipping for feeding purposes into their respective States or Territories.

As is always the case in enforcing quarantine measures, some inconvenience and hardship were occasioned, and there has been objection on the part of sheep owners to the stringency of the measures applied. It is impossible to enforce a quarantine in such a way as to be effective in preventing the spread of a contagious disease and at the same time to avoid hardship to stock growers and shippers.

The shipping of exposed sheep to market centers for slaughter, and the occasional receipt at such places of sheep that had developed the disease en route, resulted in many instances in great loss to the owners on account of the low prices that they were obliged to accept.

The measures prescribed by the Department were made just as lenient as they could be, considering the nature of the disease, as the Department felt that it should not make its regulations unduly oppressive and should extend every facility to sheep owners for marketing their sheep consistent with the nature of the disease and with proper sanitary precautions.

In this matter the Bureau is standing between two conflicting interests. The sheep raisers in the infected area, on the one hand, wish to have their stock let out for marketing or feeding. The

buyers and feeders in other parts of the country, on the other hand, want to be protected against the purchase of exposed sheep in which the disease afterwards develops. In this situation we have done our best to be fair to both sides. Nevertheless, complaints have been received from eastern feeders that the disease has broken out in sheep bought by them after having passed inspection, and the Bureau has been asked to make settlement for losses resulting therefrom.

The nature of the disease makes it impossible for even the most careful and expert inspector to detect the presence of the infection in all cases before it has manifested itself in actual lesions, and this fact was a strong reason for requiring not only the inspection but the dipping of all exposed sheep, or sheep which, while apparently healthy, had formed part of diseased bands.

There has been some complaint on the part of sheep owners that Bureau inspectors have held up sheep which did not have lip-and-leg ulceration, but merely had sore mouths caused by frosted grass or the coarse, rough feed of winter. It is significant, however, that sore mouths have not only been observed in grazing sheep, but have also been found in suckling lambs before they had commenced to eat herbage of any sort.

It must be remembered that necrobacillosis in all its various forms, whether mild or virulent, is an infectious disease, caused by the same germ; and further, that it is also what is known as an inoculation disease; that is, the necrosis bacillus requires for its entrance into the body an impaired or broken tissue. The effect of frosted herbage, hard wiregrass, and other similar substances is to produce wounds into which the bacillus may enter and cause disease. When sheep are injured in this way and apparently have only the mild form of sore mouth, in territory where the malignant form of the disease prevails and where the wounds are very likely to be infected with the germs, it is only a matter of a little time when the disease is likely to develop in them.

Reliable evidence has been obtained in a number of instances showing that the disease was undoubtedly contracted by healthy sheep from infected premises, and it is very probable that many outbreaks have been produced through infected trails, cars, loading chutes, etc.

With regard to the requirement of dipping, it may be said that the disinfection by dipping of sheep that have been exposed to a contagious disease of this kind before allowing them to be placed with healthy sheep is a requirement that is in entire accord with the best scientific knowledge regarding contagious diseases. The disinfection of such sheep is required for the same reason as the disinfection of harness, utensils, and equipment in a stable in which animals affected with a contagious disease have been kept; that is,

even though certain animals are not actually affected with the disease, if they have been in contact with diseased animals or infected premises, they are likely to have the virus on their wool or on their bodies in the same manner that such virus might contaminate any inanimate object that had come in contact with diseased animals.

Bearing in mind the nature of the disease, the limited information regarding its extent, and all the facts which I have stated, it is difficult to understand how any more lenient method could have been adopted by the Department of Agriculture in dealing with the disease. If it is to be controlled in any effective manner it is essential that more or less stringent measures should be taken, and the Department has endeavored to make its requirements no more strict than necessary, and to permit the movement and marketing of sheep with just as little interference as possible, consistent with effective work. We have already had complaints of eastern buyers, as before stated, that the disease was breaking out in sheep which had passed inspection.

An example of the damage caused by necrobacillosis in other species than sheep and also of the danger that would result from its spread is found in the case of the San Luis Valley of Colorado. Hog raising is an important and paying industry in that valley, but has been greatly interfered with by necrobacillosis, which has affected hogs there for several years. It seems likely that if the malignant form of necrobacillosis should become transferred to other sections where hog raising is extensive, such as the Middle West, the same disastrous results might follow.

If we are to succeed in controlling this disease, the efforts of the federal and state officers must be backed by the cooperation of the sheep raisers. If each individual flockmaster would apply effective treatment and cure the disease in his sheep and eradicate the contagion from his corrals, the disease could be sooner and more easily stamped out and the troublesome quarantine restrictions removed. Many owners have treated their sheep, but it is necessary that this should be more generally done. The disease yields to proper treatment in most cases, and effective methods of treatment have been prescribed by the Bureau of Animal Industry and by state veterinary officers. It is within the power of the sheep raisers, by cleaning up their flocks, to hasten greatly the time when the quarantine can be raised, and the Bureau earnestly desires the help and cooperation of all who are interested in bringing about that result.

Even in the case of the mild form of sore mouth as it occurs in lambs, it would be much better if the owners would keep these lambs on their ranges or premises until the disease has run its course and the lambs have become well. This would only require holding them for a few weeks longer, and they could then be sent to market in good condition and without any likelihood of being held up.

I want the stockmen of the country to realize that the object of the Bureau's work is to protect and benefit their industry, and that in all our work we always have this object plainly in view. We must look at the matter in a broad way, however, and consider the good of the live-stock industry throughout the country as a whole. It is not to be thought for a moment that a progressive nation such as ours would permit an injurious and destructive contagious disease of live stock to spread all over the country just because effective measures for its control would entail some inconvenience and hardship on the stock raisers in a limited area.

But the object of our work is not solely to protect the sections of the country where the malignant form of the disease has not spread. The interests of the sheep raisers in the infected territory demand that the disease should be controlled; and while the process may be somewhat burdensome to them for a time, the ultimate result will be greatly to their benefit. So whether we view the subject in a broad way from the standpoint of the live-stock industry of the country as a whole, or from the narrower standpoint of the interests of certain limited sections, the work of quarantine and suppression of a contagious disease can only be regarded as beneficial in the end.

In endeavoring to control and eradicate contagious diseases of animals, however, the Bureau of Animal Industry always tries to proceed in such a way as to accomplish that result with the least possible disturbance and inconvenience to the movement and marketing of live stock. We endeavor to combine scientific knowledge with practical common sense. We are always willing to listen and learn, and are glad to confer with those engaged in the live-stock industry and to carry out their wishes so far as possible. It has been very gratifying indeed for me and my assistants to be able to meet with the wool growers and the various state sanitary officers and to discuss this subject from the different viewpoints. I trust that this discussion has resulted in all of us acquiring more information on this very important subject, and that this conference will be of benefit to the sheep industry.

II. LIP-AND-LEG ULCERATION (NECROBACILLOSIS): ITS CAUSE AND TREATMENT.

By JOHN R. MOHLER, V. M. D.,
Chief of the Pathological Division.

INTRODUCTION.

For the past few years, especially during the winter season, the Bureau of Animal Industry has been appealed to on numerous occasions from various sections in the Northwest to investigate attacks of diseases affecting the sheep in these localities and to furnish aid in the treatment and eradication of these maladies. From the increasing number of letters received it was apparent that in some sections a serious condition of affairs existed and that it was not an idle appeal that had been made for help. Under a great variety of names a disease was described which seemed to point to a more or less common origin. In short, this was found to be the case when inspectors were sent into the infected regions, and what was described under so many different names was found to be in reality various manifestations of one and the same disease, namely, infections with the necrosis bacillus, a germ that was described early in the eighties by various European investigators and has since been found to be very widely scattered and the causative agent of many of the ailments which affect domestic animals. In this connection it may be stated that all the differing manifestations of the infection by the necrosis bacillus in the various species of animals are frequently brought together under the one general term—necrobacillosis.

During the work of the past year a very contagious form of sore mouth in lambs was observed, and studies as to its causation were instituted. This affection, with which every experienced sheep owner is more or less familiar, is designated by various names, such as sore mouth, sore lips, warty mouth, warty nose, impetigo labialis, ecthyma stomatitis, etc.

The disease has been observed in this country in both the East and the West as well as in various parts of Europe off and on for the past twenty years, and until quite recently little effort has been made to find the causative agent or to check its spread. European investigators are not at all in accord in attributing a cause for the malady, but that they have been working with this same sore mouth affection

is not to be doubted when one reviews the literature on the subject and reads the very accurate descriptions of the lesions found. If there were any doubts from the published descriptions they would be dissipated by the photographic illustrations that accompany the articles. Strange as it may seem, most of these writers have not definitely determined the cause of the trouble, but a small number of able investigators have good reason for incriminating the bacillus of necrosis.

It has previously been the habit of many sheep owners to ascribe the cause to coarse grass, bristle grass, shad scale, bunch grass, clover, alfalfa, beet tops, and to weaning of the lambs, to dew on the grass, to frost, and to a host of other causes. These in all probability are highly predisposing factors but not the actual cause.

The older veterinarians, before anything was known about the rôle of bacteria in the causation of disease, also held to the same opinions about the causes of disease in general, but a review of their writings shows that their opinions were only theories or guesses at the real cause. No experiments were made to prove their assertions, but, as in human medicine, many of the obscurities of disease are now being uncovered by definite, convincing, and indisputable researches.

It is a significant fact that from numerous specimens examined by the Bureau of Animal Industry last year the necrosis germ has been isolated, and inoculation both of lambs and older sheep with the diseased tissues from the lambs' mouths has produced the disease. No observing man could advisedly question its contagiousness, and from this fact alone the Bureau is bound to take some cognizance of its existence.

HISTORY.

Some of the early writers seem to have been convinced that the disease termed lip-and-leg ulceration in this country was in no degree contagious, but at a later period many investigators opposed this opinion and strongly maintained that it spread from sheep to sheep by means of some contaminating germ.

Gilruth, of New Zealand, in 1900 reported on a disease which he termed acute facial eczema in sheep, manifested by an eruption on the face and ears of lambs. He considered it at that time to be due solely to errors of diet from eating rich feed like rape or clover. His assistant, Clayton, made an excellent report on this eruptive disease of the lips and face among a band of lambs. A large percentage were affected, the whole of the face in some cases being covered by a mass of scabs. In others the trouble was located around the mouth and nostrils only. The feet and legs were not affected, but the lambs fell off considerably in condition. In this outbreak Clayton could find nothing to account for it in the way of rape or clover, but nevertheless considered it to be dietetic. Subsequently,

in 1906, Gilruth described the appearance of a similar disease affecting the skin of the mouth and nose of sheep in New Zealand. He called it acute dermatitis of the face, and his experiment demonstrated fairly conclusively that a micro-organism was the cause. About 100 of the sheep became affected, and only a few died, not as a direct result of the disease but because of the interference with feeding and breathing induced by swelling of the skin of the lips and nostrils.

In 1907 Gilruth recorded the same disease under the term acute stomatitis affecting the lips and mouths of lambs, and found the cause to be the same germ that caused the disease the previous year among older sheep, although the actual lesions produced were somewhat different. The owner had used the pasture for five years, but previous to the outbreak no affection of the mouths or lips of any of the flock had been observed at any time. A short time after lambing the shepherd observed several lambs with what he described as scabs affecting the lips. Believing the disease to be contagious, he slaughtered and buried the first ten or twelve he found affected. Fresh cases appearing with great rapidity, he notified the chief veterinarian and requested an investigation. After the lambs were subjected to the usual operations of earmarking, castration, and docking, 50 per cent developed more or less extensive ulcerative sores on the stump of the tail, while a considerable number showed similar lesions around the earmarks. Some of these tail and ear ulcerations occurred on lambs which showed no lesions of the lips and mouth. Curiously enough, in no instance were lesions found present in the region of the scrotum after cutting, a fact the more remarkable because the disease had been transferred in many cases from the lips and mouth of affected lambs to the udder and teats of their mothers.

In 1908 Gilruth again reported upon sore lips in lambs in New Zealand. Treatment of one band under investigation was very perfunctorily carried out, and four days after the lambs were docked and castrated 7 of the lambs and 1 ewe were found dead. All the dead lambs were wethers, and in each case the scrotum was tremendously swollen, ulcerated, and gangrenous. Only a small percentage of lambs were affected with sore mouths, but nearly all showed ulceration of the tail stumps, while the scrotums of over 80 per cent of the castrated lambs were so affected as to require treatment, and the same virulent germs were found in all. Besides the lesions and deaths among the lambs there was at the same time a similar disease affecting the ewes of the same band, which occurred principally in the neighborhood of shear wounds and on the udders through contamination by the sore mouths of the lambs. It therefore seemed quite certain that the shears as well as the docking knife became contaminated with the specific germs. Gilruth in his last report states that while at first all the cases brought to his attention were confined to lambs,

he has since seen the disease among two-tooth ewes, and even older ewes. The disease was proved to be contagious by inoculating two healthy ewes.

McFadyean, in 1901, described a disease similar to lip-and-leg ulceration, which is usually met with in England as a troublesome affection of ewes and young lambs and called malignant aphtha. In the case of the lambs the disease is manifested by the formation of sores on the nose or lips, and the ewes develop similar sores on the teats and udder. The disease apparently is spread only by direct application of matter from the sores to the skin. This author states that in Scotland a disease exists among the lambs of any age, and rarely in adult sheep, known locally as orf. He states that it is not of rare occurrence, but has received little attention in veterinary literature. On the face the lesions are present on the hairy surface of the lips and around the nostrils. On the legs the sores may form anywhere between the hoof and the knee or even higher, and sometimes the sensitive structures around or between the claws are involved.

Armatage, in his English work, "The Sheep Doctor," describes a contagious ecthyma or malignant aphtha which corresponds very closely with the condition seen in the lambs in the sheep-raising sections of the Northwest. He says:

In the lamb the disease first attacks one or both nostrils, the margins of the lips, and the front of the gums. The skin first shows an elevated portion of skin which is tender from inflammation, shortly converted into a spreading sore, and later covered by a scab which is readily removed. Similar changes are seen on the lips and gums, succeeded by a croupous covering varying considerably in size, often productive of much damage to the gums.

Berry, in 1901, reported this disease as existing in England, Scotland, and Wales, where it is known as contagious pustular dermatitis, orf, or crusta labialis, and is said to be more familiar to the shepherd than to the veterinarian. Sheep of any age seem to become infected, but it is more frequently and readily transmitted among lambs or sheep under 1 year old. In many outbreaks nearly all the sheep become infected, and diseased sheep brought into a band will transmit the disease to many of the healthy animals within a fortnight after mixing the flocks. The fatality of the disease is not great, although fluctuating from time to time.

W. Williams, in 1894, described under the term orf, or carbuncle of the coronet in sheep, a disease occurring more particularly in young sheep, but occasionally in old ones. It is characterized by lameness, inflammation of the coronet or the space between the claws, which latter develops into angry-looking ulcers. These ulcers may attain a large size, fill up with granulations, or bleed readily. Similar ulcers or sores may appear on the face and head. It is not a fatal disease, but is troublesome, and when well estab-

lished is slow to heal. Williams also used the term *crusta labialis* for the affection when the lesions are more marked on the face, although the eruption is seen on the coronets and pasterns as well as the lips and nostrils.

Hutyra and Marek, of Hungary, reported in 1906 the presence of pustular stomatitis in two imported bucks. Three days after they were turned in with native sheep the latter developed symptoms, and in a short time almost the entire band of 500 sheep showed eruptions and ulcers on the lips, corners of the mouth, and edge of the nostrils. The disease spread rapidly, but was in a benign form, the only two animals which died developing lesions in the lungs.

Hasenkamp, in 1908, observed numerous cases of ulcerative stomatitis in sheep of Germany which were affected with foot rot, and was able to incriminate the *Bacillus necrophorus* as the causative agent of both these conditions. In some of these sheep he observed embolic areas of necrosis in the liver and lungs as a result of secondary infection.

Moussu, of France, and Dollar, of England, describe an ulcerative stomatitis of sheep which corresponds in all particulars to the disease as seen in western lambs in the United States, but add that they have observed a mortality of 15 per cent.

Besnoit, another French writer, in 1901 gave a good description of this same ulcerative stomatitis in lambs and goats, and referred to other authors who had previously written on the same subject. The disease was formerly attributed to dirt and carelessness, but Besnoit considers it a grave and contagious malady due to a specific virulent germ.

In the work of Cadéac, published in Paris in 1908, a very good description of ulcerative stomatitis of lambs is given, and the necrosis germ is given a prominent place in the causation of this disease. The evolution of the disease is stated to be very rapid.

Leclainche and Vallée have made an unpublished observation regarding enzootic necrosis of the lips and nose of French sheep, from which they recovered the necrosis bacillus. The process advanced until in some cases it completely destroyed the lips, making the eating of feed so difficult that some deaths occurred.

Knowles, in 1907, described very fully and accurately a disease occurring among the sheep of southeastern Montana which affected the lips and legs of the animals. He was the first writer to apply the name infectious lip-and-leg ulceration to this disease, which is quite appropriate, owing to the character and location of the lesions. Knowles found the necrosis bacillus to be the cause of the lesions, and succeeded in transferring the disease from infected to healthy sheep by a series of inoculation experiments.

Craig and Bitting, in Bulletin 94 of the Indiana Agricultural Experiment Station (1903), state that young and debilitated lambs when kept under unhygienic conditions are prone to contract the ulcerative form of sore mouth. They claim that the disease is no doubt due to some of the virulent germs, as it seems to be communicated from one lamb to another.

Law, in 1900, has described, under the term ulcerative stomatitis in lambs, an enzootic affection which he says is manifestly contagious, but the infecting microbe had not then been demonstrated. A number of organisms other than the necrosis bacillus are cited as being formerly supposed to be the cause, but none of these in pure culture produced the disease.

Rushworth, in 1899, reports on aphtha or sore mouth as a very troublesome affection generally seen among sucking lambs, although older sheep sometimes are severely affected by it. Many supposed causes, such as feeding turnips, rape, etc., low vitality, unhealthy surroundings, and in aged sheep decayed teeth, have all been suggested as the cause, but the fact that the udder and teats of the ewe become affected from the lips of the lambs tends to prove its contagious nature, according to Rushworth. Apparently the lambs first become infected and the ewes are then inoculated by their lambs.

Joseph E. Wing, in his "Sheep Farming in America," describes the lamb disease under consideration as a contagious form of sore mouth, which also affects the teats and udders of the ewes. Often the sores along the edges of the lips become so troublesome as to cause the death of the lamb, more usually simply interfering with its thrift so much as sometimes to make it profitless. Wing has found that this disease often breaks out upon the mouths of western range lambs on their arrival at an eastern farm for feeding. He assumes that it is of germ origin, and therefore uses local applications of sheep dips with excellent results.

Walley, as far back as 1888, described an eruptive disease mostly seen in young sheep in England, which he termed malignant aphtha. He writes:

I am in possession of the most indubitable proofs of the infective and contagious nature of the malady, and all our old ideas as to the disease having simply a dietetic or local origin must be relegated to that limbo where so many ideas have gone during the last decade.

Sheep breeders and shepherds are quite familiar with this sore-mouth disease of lambs and are prepared to contend with it. Probably this fact has largely tended to mislead them as to the destructive character of the malady under unfavorable conditions, and has thus been the means of materially increasing their losses through

the appearance of the more malignant and dangerous forms of this disease.

For instance, in Great Britain, while the sore mouth of lambs has been known and described for more than twenty years, the venereal form was first described in 1903 by Flook. He relates the presence of extensive eruptions about the mouth and nose and a discharge from the sheath in buck lambs. The affected bucks were placed with a small flock of old ewes, and one week after 9 of these ewes showed swelling of the vulva with raw, ulcerating sores on the skin and mucous lining of the lips of the vulva. The bucks showed ulcerating sores in the sheath, and one had eruptive lesions on the upper lip. During the same year McFadyean observed the same disease affecting the vulva of ewes with the production of swelling, ulceration, and discharge. McFadyean reproduced the disease by collecting the discharge on cotton, which was placed into the sheath of a wether. On the third day a small sore covered by a brownish scab appeared on the skin near the opening of the sheath and continued to spread around the opening. A number of small ulcers formed, covered by brownish crusts. This author did not succeed in isolating any organism which he believed caused the disease, but considers the disease worthy of careful observation, and that newly purchased bucks might well be examined for this affection before being used in breeding. G. H. Williams reported on two more outbreaks of this disease in Great Britain, affecting the genitals of bucks and ewes and similar to those recorded by the two preceding writers. One ewe also showed lesions around the nostrils. In another flock of ewes he found eruptions about the lips and nostrils only, and it was to this form of the disease that Walley gave the name contagious dermatitis.

CHARACTER AND LESIONS.

It becomes evident, after reviewing the various above-described forms of this disease of sheep in different countries, that the characteristic lesions may be found on any part of the exterior of sheep where the bacillus which causes it may gain entrance; but cuts, bruises, abrasions, and exposure to devitalizing processes being less frequent upon parts covered with wool and their contact with infection less likely, it follows that the woolly portions of the body are less subject to lesions than other parts. In this country lesions upon the head, as lips, chin, nose, cheeks, gums, and hard palate, are the most frequent, while much less common are the ulcers on the legs and feet. Shear cuts and the tail stump of docked lambs are at times infected, while slit ears have been more frequently involved. In bucks frequently and in wethers occasionally the sheath is infected. The vulva of ewes has been found ulcerated in a relatively small percentage of cases, while the udder and teats even

more rarely have developed the infection, notwithstanding that the sucking lambs showed more or less ulceration and eruptions on the mouth parts. In some cases lesions have appeared in the pharynx and lungs, occasionally in the liver and stomach, and in such instances the disease uniformly results in death.

It may be advisable to arrange these various manifestations of the disease into the following classes, with the statement that further study is required to explain the reason for necrobacillosis in sheep assuming several different forms or types under what appears to be similar environment, as well as for the disease becoming virulently infective in certain cases, while in others, under practically the same



FIG. 1.—Lip-and-leg ulceration, showing lip lesions in ewe infected with germs obtained from warty lips of lamb.

conditions, there is a tendency toward latency or even spontaneous recovery.

1. The lip-and-leg form, as the name indicates, attacks the lips or legs, or both. The lesions in some bands are confined very largely to the lips and muzzle, in other bands the lesions are largely confined to the legs, while in still other bands the seat of the lesions is about equally divided between the lips and legs. This form of the disease is shown in figures 1 and 2.

The different conditions under which the sheep are kept and the character of the feed may account, in a degree at least, for this

difference in the seat of the lesions, and also to some extent for the difference in the spread of the disease, especially within the band. Thus, during the winter, when snow is on the ground and the weather

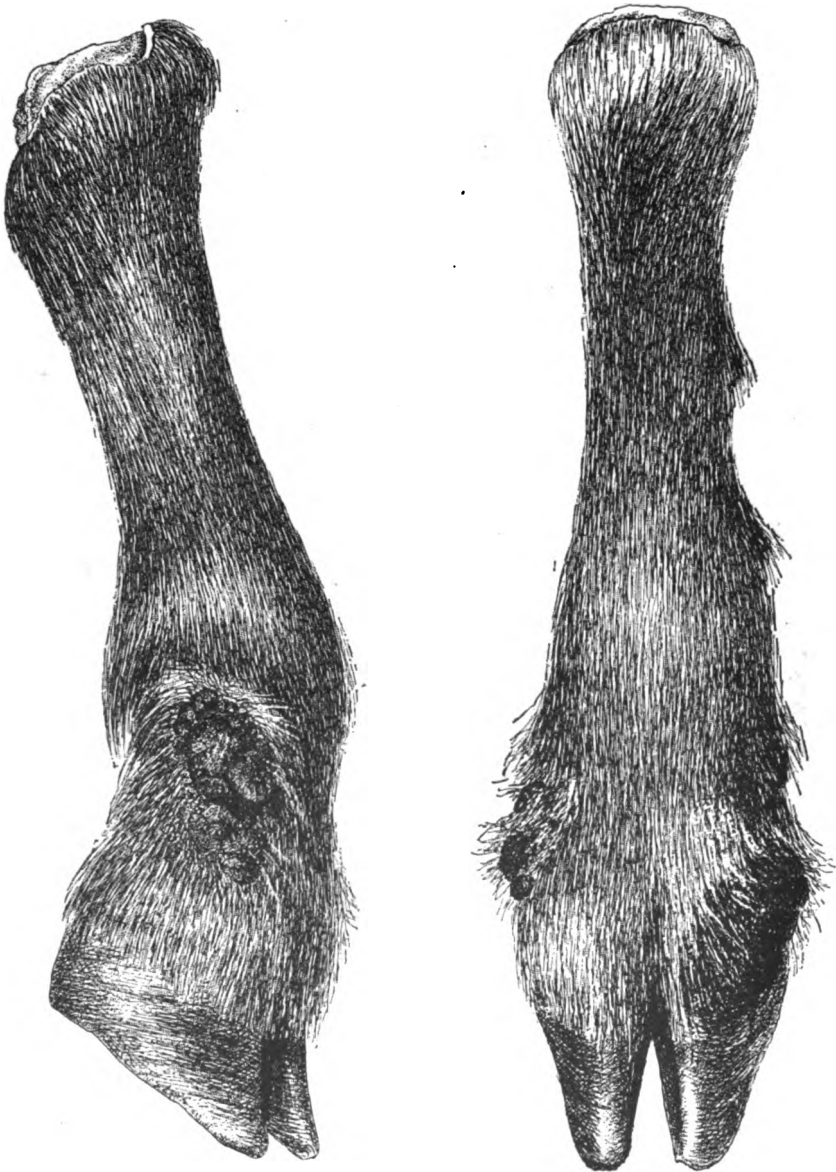


FIG. 2.—Lip-and-leg ulceration, showing leg lesions.

is so cold that the surface of the snow becomes hard and crusted, making grazing very difficult, the chances are that leg lesions would be likely to predominate, owing to the numerous scratches received

upon the legs becoming infected with the blood and bits of scab which drop from the infected sheep. On the other hand, if they were fed on a range where cactus and greasewood composed a large part of the feed, the spines of these plants would be likely to wound the lips and nose to such an extent that lip lesions would be apt to predominate. Other sheep ranging over such ground after the infected sheep had passed would under such conditions be very likely to contract the disease.

This form may assume either the active or the inactive stage. The active stage manifests itself in the various locations by inflammation, tumefaction, ulceration, and necrosis, with or without scab formation. There is more or less rapid destruction of the tissue, especially where the lesions are located on the lips or muzzle. Cases are frequently seen where more or less of the lip or the end of the nose has sloughed away as a result of the suppurative inflammation. In such lesions the predominating form of the necrosis bacillus is the long, beaded, vegetative filament located on the border of and penetrating the healthy tissue. The inactive or chronic stage is characterized by a stationary condition of the lesions, unaccompanied by tumefaction or inflammation except of a productive or proliferative character. In these

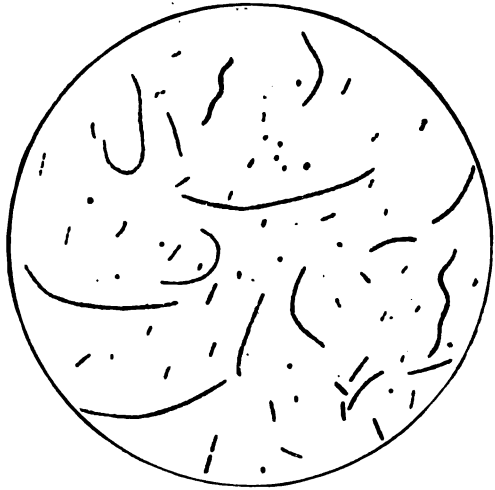


FIG. 3.—*Bacillus necrophorus* showing coccoid, bacillary, and filamentous forms.

cases the involution or quiescent forms of this pleomorphic bacillus, especially the bacillary and coccoid types, will be observed in the degenerated debris. The different forms of the bacillus are shown in figure 3 and its cultural characteristics in figure 4.

The lesions in the early stage usually appear as an acute inflammation of the skin on the outside of the lips. This pimple-like formation is attended with much inflammatory swelling, with a decided tendency toward the formation of pustules. They dry and form crusts of a dark grayish color. The growths extend rapidly and become in the course of a few days confluent, forming a large diffused scab, which when removed is found to cover an ulcerative surface. Simultaneously with this the lips become tumefied, swelling to two or three

times their normal thickness. The appetite usually remains good, but the animals feed with difficulty, owing to the sensitiveness of the affected parts. In some cases the lesion extends from the lips up over the cheeks, occasionally involving the eyelids or even the eye itself. At times a mucopurulent nasal discharge appears, which adheres to the nostrils and together with the swollen condition of the surrounding tissues causes a more or less complete occlusion of the air passages, resulting in labored breathing upon exercise. In some cases the lesions extend into the mouth, producing erosions on the inside of the lips, on the gums, and on the dental pad of the hard palate. These lesions, which are of a spongy consistence and present a warty appearance, are especially noticed on the lambs.

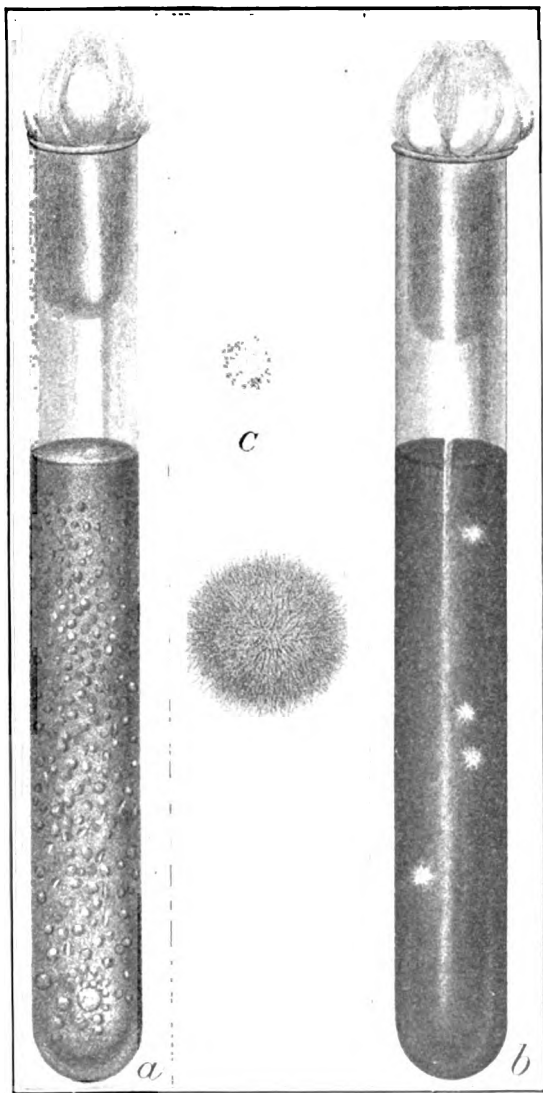


FIG. 4.—Development of colonies of *Bacillus necrophorus* in agar jelly. a, Culture showing twenty-four hours growth, with numerous small gas bubbles; b, culture seven days old showing isolated colonies which are characteristic in that their grayish centers are surrounded by fuzzy white areas not unlike the strands of loose, fleecy cotton; c, single colonies of the necrosis bacillus showing this filamentous character of their growth (enlarged). (From drawing by W. S. D. Haines.)

Lesions on the legs may coexist with those on the lips. The sheep at this time will show some lameness, especially if the ulcers appear about the coronet, in the fold of the fetlock, or in the vicinity of a joint. The progress and appearance of the ulcers upon the legs are identical with those upon the lips, and they are soon covered by a thick, dry

crust which when forcibly removed exposes a granulating surface covered with a tenacious pus.

2. The venereal form, as the name indicates, attacks the genital organs of both sexes. This form is frequently seen in connection with the lip-and-leg form, but it is also observed in some bands that do not present any other lesions.

In bucks the external part of the sheath is affected in most instances, and more infrequently the ulcerations are confined to the penis. The latter condition may be explained by the fact that a buck is liable during copulation to scratch or abrade the membrane covering the penis with burs, etc., in the wool of the ewe, while the sheath may become infected through the use of contaminated bed grounds. In certain sections the erroneous opinion has been held that this form of the disease is syphilis or clap and has nothing to do with lip-and-leg ulceration because it is rightly considered far worse than the latter. It is probable that this form of the disease, which is also known as ulcerated sheath and big pizzle, results in a larger death rate than all the others, and it was reported that in a number of instances quite a percentage of the band, in some cases the entire band of bucks, were destroyed as soon as the disease was discovered because so many of the bucks were rendered useless for breeding through a portion of the penis having sloughed off. Besides, this appears to be the most difficult form to treat, yet good results from treatment were obtained in many cases.

In ewes the lesions are located on the skin or mucous membrane of the vulva, on the under side of the tail, and in the perineal region. In a few cases discharges which collected at the lower angle of the vulva and in the wool adjacent to the perineal region indicated the presence of infection in the vagina.

The sheath form of the disease is characterized by an ulcerated condition of the external part of the sheath without the penis being affected, and is not infrequent among wethers. Constant saturation of the wool around the sheath with urine probably chafes the skin, allowing the entrance of bacilli from infected bed grounds, etc. The first manifestations of this form of the disease are the appearance of one or more very small pale yellow centers within the folds of the sheath at the juncture of the skin and the mucous membrane. Very early there forms at each of these centers an ulcer that extends outward into the skin, but rarely inward. The ulcer or ulcers extend, and frequently coalesce, so that the entire face of the sheath is covered by a single ulcer. During the early stages, in those cases where all or a considerable portion of the face of the sheath is covered with the ulcer, the entire external portion of the sheath will be more or less inflamed and tumefied.

No case of penis infection has been observed in wethers, except a few cases that had been treated by introducing strong caustics within the sheath in contact with the penis.

While this condition has been mostly observed in wethers a year or so old, two cases of natural infection were reported in wether lambs not over four months old. (See fig. 5.)

3. The foot-rot form: Owing to the dryness of the soil of a large part of the infected section in the West, this disease probably assumes a somewhat different form from the foot rot of moist localities, though foot lesions were frequently seen in connection with the lip-and-leg forms. In several instances quite a number of sheep in the



FIG. 5.—Lamb with lesions on lips and sheath. (Photograph by Dr. W. E. Howe.)

infected districts presented only foot lesions, while in other instances lesions on the feet were accompanied by ulcers on the lips. The foot lesions may first become visible either at the front or back part of the cleft, but usually the erosions make their first appearance at the heel. The inflammation rapidly penetrates beneath the horny tissue, while from the ulcerous opening there exudes a thin, purulent discharge, possessing an odor pungent and disagreeable but at the same time very characteristic.

Sex or age does not appear to have any important influence on the susceptibility of the animals, as the disease manifests itself quite generally in a flock, attacking alike male and female, lambs, yearlings, and aged sheep.

4. The sore-mouth form of the disease is characterized by warty or pustular patches on the lips, covered with slightly elevated brown crusts or scabs, usually seen in lambs during the fall of the year, though it has been observed earlier in the season, both in sucking lambs and in those that had just been weaned (fig. 5).

The disease makes its appearance very quickly, the lips becoming more or less tumefied, with a slight diminution of the appetite, especially in severe cases. In some instances food is taken with difficulty, resulting in unmistakable signs of poor nutrition and the stunting of the animal. At this stage the animal presents a greater or less number of nodules or patches on the lips, most frequently at the junction of the mucous membrane and the hairy portion. In severe cases these nodules become confluent, forming large, diffuse, fissured scabs around the margin of both lips, down on the chin, or up on the nose, or both, in which case the whole muzzle is affected. The removal of these scabs exposes either a purplish-red, easily bleeding surface, or a pitted, yellowish-white ulcer covered with pus, some of which will also be found attached to the under surface of the removed crust. In very extensive lesions there may be sufficient pus so that a small quantity will exude from beneath the crust on pressure. In a few cases the disease spreads to the mucous membrane of the mouth, forming small ulcers or fungoid elevations, soft, red, and of a spongy consistence. In both corners of the mouth there are usually present small yellowish necrotic areas which are generally the last to heal. A typical, offensive odor, similar to that of Limburg cheese, is given off from the infected parts.

In some of the most extensive cases of this form there is a loss of tissue due to ulceration, resembling that seen in the lip-and-leg form. In these lesions the active, vegetative filaments will be found penetrating the healthy tissue. In unmolested cases, except probably the more extensive of this form of the disease, the crusts remain intact until the lesions are fully healed, when they drop off, leaving a clean, healthy looking surface. In such lesions the quiescent coccoid and bacillary forms of the bacillus will predominate, while only an occasional short filament will be observed.

We have positive proof of numerous cases of the malignant type of lip-and-leg ulceration developing from the lesions in sore-mouth lambs, convincing alike to the flock master and to the inspectors who had supervision over the animals.^a

CAUSE OF THE DISEASE.

There can be little doubt that the disease is primarily the result of abrasions of the skin and other tissues, allowing the access of the causal organism. The latter may be a natural habitant of certain localities or of certain vegetation. One factor that is predisposing

^a The writer acknowledges his indebtedness to the veterinary inspectors of the Bureau of Animal Industry who have submitted reports on lip-and-leg ulceration, especially to Drs. John S. Buckley, George A. Johnson and Charles H. Zink.

in these cases is a prolonged drought which renders the feed scarce, inducing the sheep to browse on thistles and roughage which cause the necessary abrasions. In fact, it is frequently noted that after rains, with the consequent growth of luxuriant feed, the disease becomes checked and the affected animals rapidly recover. There seems to be some connection between dry weather, or rather very dry feed, and the appearance of the disease. While there are many factors in dry herbage liable to produce slight abrasions of the lips necessary for the entrance of germs, in succulent pastures there are few or none. However, such abrasions by themselves will not produce the disease, but when they become infected with the germs of necrosis, lip-and-leg ulceration follows. The necrosis bacillus, which is very widely distributed by nature, will not enter a healthy tissue, requiring, as it does, an abrasion, puncture, or wound through which to gain access. Of course a spine or prickle, if contaminated with these germs at the time of puncture, will act as a direct agent of introduction.

In order to obtain some information on the question as to whether the object making the abrasion is itself infected or if the wounds made by noninfected bodies become contaminated subsequently to the injury, two specimens consisting of bunch grass and shad scale were examined and inoculated into experiment animals, but with negative results. Of course these findings are in no way conclusive, merely indicating that the infection was not present on the particular specimens examined. On the other hand, tags of wool examined and tested on animals in the same manner gave positive results in two instances. The manure of sheep was also examined to ascertain if, as in hog manure, the organism exists there normally, but in no instance was the bacillus observed. In order to prove or disprove a theory that had originated in one of the infected districts, a careful study of the foot lice of sheep was made in order to determine if they played any part in the transmission of the disease, but these results were likewise negative.

There are several conditions which are responsible as predisposing factors for infection by this organism.

1. Lambs often become affected with sore mouths by coming in contact with the infectious principle. Hard, dry scabs, warty in appearance, are produced frequently, covering the entire lips, and which upon being removed leave a raw, granulated surface with or without an exudate of pus. These lesions may be present in lambs before they are weaned, in those that have been weaned, or in lambs which are forced to the range for hard dry feed after being on succulent forage. It is not, however, the feed or the pasture or the fact that they have just been weaned which of itself causes the lesions;

but in addition to these predisposing causes, the necrosis bacillus becomes present and the disease continues to spread.

2. Sheep are sometimes forced to wade through alkali gumbo mud to reach water in the lakes and reservoirs when they become low. This mud becomes matted in the hair and wool of the legs, and becoming dried by the sun and winds may be rubbed off, pulling hair and skin with it, and thus opening the way for the entrance of the necrosis bacillus followed by ulcerations on the legs.

3. In the winter time the tissues, especially of the legs and sheath, may become devitalized as a result of freezing or of frost bites, thus allowing the necrosis bacillus to gain lodgment and develop.

4. Injuries in the region of the legs and feet due to thistles, cacti, briars, bruises, etc., and wounds of the lips as a result of picking up harsh forage or frozen forage or in breaking through crusted snow for feed, provide favorable conditions for the entrance of the bacilli.

While recognizing the importance of the remote cause, it is to the proximal cause that we give credit for instituting the disease process under consideration. For instance, in lip-and-leg ulceration the proximal cause is the *Bacillus necrophorus*; the remote cause may be a puncture of the cactus. Note here that the proximal cause is invariable, the remote cause variable—for, instead of being the cactus, it may be a sharp-pointed particle of food. Again, the origin of necrotic quittor in the horse may be a nail in the foot, tread, scratches, etc. It is a variable source. But when by our investigation we find the necrosis bacillus associated with this process, we are warranted in laying hold of that micro-organism as the proximal cause—the cause which gives title to the disease process, or which, on the other hand, may receive its name from the disease. So in necrobacillosis of the intestines in calves. The immediate cause of the necrosis is the necrosis bacillus; the remote cause may be any bacterial agent capable of injuring the mucous membrane, or chemical effects connected with the feed—anything, for that matter, that could produce a catarrhal or eroded condition of the intestinal mucosa.

Lodgment in the tissues of the body of a susceptible animal is all the necrosis bacillus requires. Once this is secured where it may develop and throw out its deadly volatile toxin, all tissues with which it comes in contact become alike a prey to its necrosing action. As a result we may have necroses of the skin, muscle, hoof, cartilage, bones, mucous membrane, navel, and internal organs. In order to determine the presence or absence of the necrosis bacilli in these tissues inoculation experiments furnish an important and definite aid in diagnosis. The tissue alteration in the rabbit after inoculation with this bacillus is so characteristic as to become an essential factor in the identification of the organism. Furthermore, the work of recovering the necrosis bacillus is much simplified by the injection of

these animals, particularly if the bacilli are present in very small numbers in the specimen to be examined.^a

ECONOMIC IMPORTANCE OF THE DISEASE.

In considering the economic importance of this disease it is necessary to remember that many other infections are produced by this organism in many other species of animals, some of which are more grave than lip-and-leg ulceration. The presence of the latter disease on the range would indicate the possibility of the causative germ affecting other susceptible animals in any tissue in which it might find lodgment. Thus the importance of this organism is far beyond even its relation to lip-and-leg ulceration, since it affects calves, pigs, goats, adult cattle, horses, deer, rabbits, dogs, and chickens, and various forms of necrobacillosis may occur in these animals on premises contaminated with the infectious principle of this disease. Therefore, as a large majority of species of domestic animals are susceptible to this infection, and as a constant relation may exist between an attack of one form of necrobacillosis and the previous occurrence of another type of the infection in the same or another species of animal, it behooves one to prevent any susceptible animal of whatever species from coming in contact with a diseased one, or with such corrals, sheds, manure, and pastures as might be harborers of the contagion.

In whatever part of the animal body the *Bacillus necrophorus* may have instituted the inflammation which characterizes its presence, by whatever name the disease process may be called, be it foot rot, necrotic quittor, necrotic scratches necrotic vaginitis or metritis, or necrotic stomatitis, there we find a hotbed of infection and the certain groundwork of an enzootic. Hence, the occupancy of the calving stall by a cow affected with foot rot or by a cow suffering with a vaginitis dependent upon this bacillus is sufficient to insure the development of cases of necrobacillosis. The same principle is involved in the dissemination of the disease through one or more litters of pigs. The very first investigator in this line made the experiment of placing a healthy calf in a stall with two calves affected with sore mouth. The third calf came down in five days with the same malady. The author considered the calves' habit of licking one another as being chargeable with the transmission of the disease.

The proof of the transmissibility of the disease from one species to another was first secured by Dammann, who inoculated a bit

^a For a detailed study of the bacteriology and pathology of the *Bacillus necrophorus* the reader is referred to Bulletin 67 of the Bureau of Animal Industry, entitled "Necrotic Stomatitis, with Special Reference to its Occurrence in Calves (Calf Diphtheria) and Pigs (Sore Mouth)," and to Circular 91 of the same Bureau, entitled "*Bacillus necrophorus* and its Economic Importance," both publications by Mohler and Morse, of the Pathological Division.

of necrotic material from the mouth of a calf dead with the disease into the mouth of a 4-day-old lamb. In four days the lamb died, with post-mortem findings which established the success of the experiment. Recent experiments conducted by the Bureau of Animal Industry have likewise shown that necrosis bacilli obtained from lesions of lip-and-leg ulceration will produce similar ulcers in hogs, horses, calves, and chickens which have been artificially infected by them. Moreover, cultures of the necrosis bacillus from warty lips of lambs produced ulcers on the penis of bucks, vulva of ewes, lips of old ewes (see fig. 1), and between the claws of adult sheep. On the other hand, cultures from foot rot of sheep and from the testicle of a buck produced lesions on the lips and nostrils of lambs, while bacilli recovered from the liver of a cow caused ulcerations on the lips and mouth of an adult sheep.^a

That this transmission of the *Bacillus necrophorus* from one species of animal to another occurs under natural conditions is amply demonstrated not only by the observations and experiments of this Bureau, but also by the recorded cases of other observers, both American



FIG. 6.—Head of hog affected with necrotic stomatitis due to the necrosis bacillus. The lower lip has sloughed away, exposing the teeth. (Sheep placed on an eastern farm where losses from this disease in hogs had occurred developed lip-and-leg ulceration three weeks after their arrival. (Photograph by Dr. Herman Busman.)

and foreign. Law, in his work on "Veterinary Medicine" (second edition, vol. 4, p. 691), maintains that such transmission is impossible, and also leaves the impression that this bacillus is not transmissible from one organ to another organ of the same species, but these statements are entirely contrary to the experience of those who have observed the disease. (See figs. 6 and 7.)

On account of the possibility of the wide dissemination of this disease, the loss in condition of the affected animals, the stunting of growth or "setting" of the lambs, and the cost, time, and labor of treating the disease in an affected band, it is evident that the importance of the infection has not been overestimated. Fortunately, if

^a In these investigations the writer has been ably assisted by Dr. Jacob Traum, of the Pathological Division, to whom he extends thanks.

taken in time, the disease in the vast majority of cases responds readily to treatment, the principal requisite being vigilance on the part of the herder to cut out as soon as they occur all cases of the infection, which should be placed in the hospital band for hand treatment.

The losses have varied considerably in the different States and sections. One company lost 3,000, or 10 per cent, in 1909; another lost 700 out of 2,000 old sheep, besides a shrinkage in the lamb crop due to abortion; while still another flock master placed his loss at

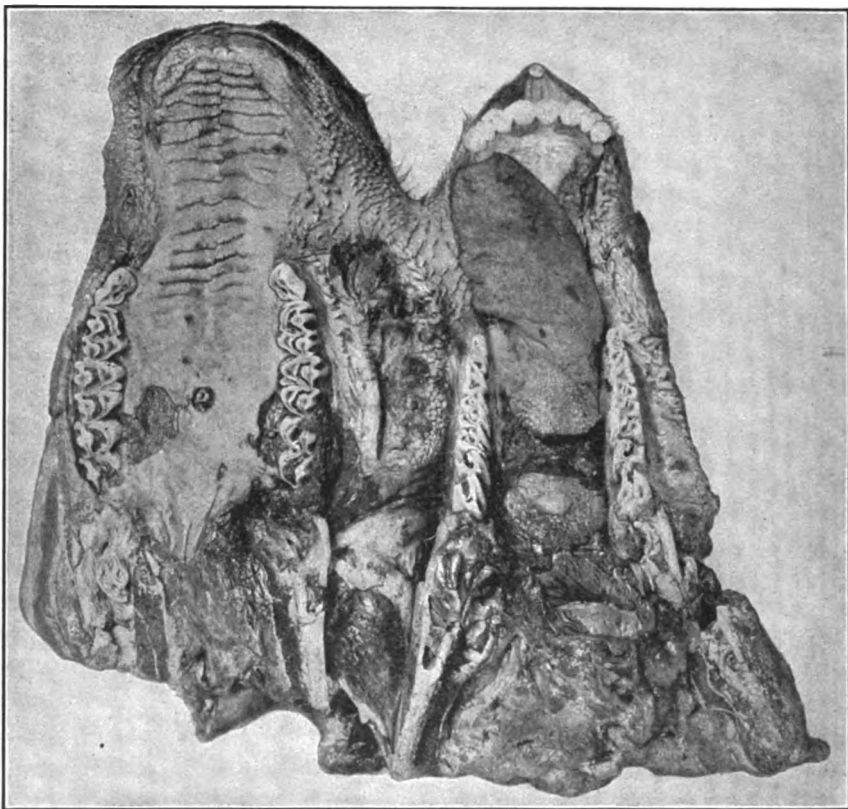


FIG. 7.—Lesions on the tongue, cheek, and hard palate in calf diphtheria, due to the necrosis bacillus. (This calf with 18 others became infected by being placed in a corral where sheep with lip-and-leg ulceration had been. Other calves from the same herd placed on another part of the ranch remained healthy.) (Photograph by Dr. Harvey B. Hood.)

\$15,000 from the effects of the disease. Bucks, more valuable in proportion to numbers, are lost to service or become the greatest menace to uninfected bands. Segregation of the infected sheep, of no great consequence in a dry band, when attempted in a lamb-and-ewe band means separation of the old from the young, resulting in the "bumming" of numerous lambs in the band and a consequent financial loss. Flock masters who have experienced an active attack of this disease in their lambs realize its importance and the necessity

for drastic measures in holding the disease in check. Other owners, whose sheep have had only a mild attack, scout the seriousness of the disease but may yet learn of its devastating tendency under unfavorable conditions. It is evident that sheep are affected but mildly under favorable climatic conditions and with abundant nutritious feed. When thus affected the animal may quickly and even spontaneously recover. But in fall and winter, when bad weather and poor feed tend to lower the powers of resistance, the disease quickly makes great headway with a greater relative virulence, and in consequence a certain number of animals become so badly affected that no hope of cure at a reasonable cost or in a reasonable time may be entertained.

TREATMENT.

In prevention lies the most important means of keeping the band clean; in treatment lies the only means of making a diseased band healthy.

Starting with a clean flock of sheep and wishing to introduce new blood into the band, a quarantine of two weeks is advisable; then, if no case of the disease has made its appearance, it will be safe to place the newly arrived sheep with the rest of the flock. A very careful examination of all sheep, especially those intended for breeding purposes, should be made, and in the event of finding any infected sheep in the band these should be cut out, thrown into a hospital band, and treated at once, keeping very close watch on the flock for any new cases that may develop later.

Prevention should therefore be carried out along three lines: (1) Separation of the sick from the healthy animals; (2) close scrutiny of the sheep that have been exposed to infection by contact with affected animals or premises, or otherwise; (3) complete disinfection of all pens, corrals, and sheds, as the necrosis bacilli will retain their virulence under favorable conditions in and around the sheepfold for several years. The walls, racks, and troughs should be sprinkled with a 5 per cent solution of sheep dip or other similar disinfectant. The manure and a portion of the surface soil of the corral should be removed and the ground sprinkled with the disinfectant solution. If possible, the healthy sheep should be taken to new and uninfected bed grounds and pastured on uninfected range. Experience has shown that sound sheep may be safely pastured on land that has been previously occupied by animals suffering from lip-and-leg ulceration if a winter's frosts have been allowed to intervene. The germs of the disease seem to be subdued effectively by this means, and pastures which have become contaminated in one season may be considered safe for their customary usage during the following season. However, the impossibility of changing range in many cases, in some not even temporarily, makes quick eradication the more difficult.

The treatment of these affections occasioned by the presence of necrosis organisms, no matter how many varieties of the disease may make their appearance, can be reduced to a few words, namely, disinfection and cleanliness, or disinfection and prevention. While selecting treatment for that portion of the flock in which the disease has become actually established it should be remembered that the principal requisite is to expose properly the affected surfaces in order that the applied remedy may destroy the infectious matter which has lodged upon them. The remedy which will accomplish this most readily and at the same time without giving rise to harmful secondary conditions is evidently the one that should be given preference.

Treatment of this disease by local antiseptics is very satisfactory if begun in time and applied energetically. It should not be deferred, as better results will be obtained by attacking the outbreak as soon as discovered than can be expected if the disease is permitted to spread among the band or penetrate deeper into the tissues of the affected parts.

In mild, unadvanced cases of the lip and leg form the best results are obtained by removing entirely the scabs and shreds of tissue from the diseased areas by means of a piece of wood sharpened to the proper angle, and applying three or four times weekly a solution of one of the cresol or coal-tar dips, or, what is far better, an emollient dressing containing 5 parts of one of these dips, 10 parts of sublimed sulphur, and 100 parts of mutton tallow, vaseline, or lard. In fact, this form of the disease responds quickly to any of the common antiseptic solutions, and it is astonishing how speedily the majority of these cases improve after careful hand treatment.

In actively progressive cases or in aggravated, chronic forms it is desirable to remove the scabs, scrape all the soft, spongy tissue from the ulcers, and touch the affected area with a 10 per cent solution of zinc chlorid or nitric acid in the strength of 1 part to 7 parts of water. Many other remedies have been tried with more or less success, but these two solutions have given the most beneficial results. As these solutions are quite penetrating and extremely caustic in the above strength, they should be handled very carefully and applied to the diseased parts only. Unfortunately, many have used an excessive amount of these very irritating solutions on the principle that if a little is good, more is better. A pointed stick, covered at its point with a piece of cloth or a tag of wool, will answer nicely for making the application of the solution. After using either of these solutions, the subsequent treatment should consist of three applications weekly of the previously mentioned emollient dressing, which is antiseptic but not caustic.

Care must be taken with these caustic solutions, as it is possible to do more harm than good if they are carelessly applied. In fact, the

indiscriminate use of strong caustics or the drastic scraping of the ulcers with a sharp knife is detrimental rather than beneficial, as in both cases harm has been done in exposing fresh unprotected surfaces to reinfection.

While a cure of the majority of the chronic and severe cases may be accomplished with four or five weeks of this treatment, the expense of any treatment applied to the small percentage of these cases which resist this method of handling will usually amount to more than the value of the animal when recovered. Therefore, when the number of old cases in the band is small, and the lesions deep, long standing, and resistant to treatment, their destruction is recommended.

Where large numbers of sheep under range conditions become affected and all require hand treatment, the problem is a difficult one. Should the disease attack a large number of animals on the legs and feet, and hand treatment is impracticable, the ulcers may be best treated by causing the affected sheep to pass three times weekly through a shallow trough containing a 5 per cent solution of any of the recognized sheep dips, but care must be taken to insure the fluid coming in direct contact with the sore parts. Those badly infected cases which show a tendency to resist treatment should be hand treated and the affected parts curetted and properly drained. If the lesions are on the coronary band or hoof, all the diseased or loosened portions should be removed with the knife. As in everything else, diligence and careful attention are necessary for successful results in these stubborn cases.

Treatment of the venereal form especially demands this careful handling. The penis of the bucks, if found diseased, should be forced out of the sheath and the necrotic patches cautiously cauterized with the zinc chlorid or nitric acid solution previously mentioned, and dressed daily by injecting a 1 per cent sheep-dip solution, a 1 to 500 permanganate of potash solution, or a 25 per cent solution of peroxid of hydrogen into the sheath until cured. If the penis or inner part of the sheath is extremely ulcerated and the prospects of cure is not favorable in a reasonable time the animal should be killed. Lesions on the external part of the sheath are treated like similar lesions on the lips and legs. All the tags of filthy wool should be removed, and if the lesions are mild, treat with mild antiseptics every two or three days; if severe or chronic, cauterize first and then dress with mild antiseptics three times weekly. Care must be observed, however, not to overdo the cauterization on this part, as closure of the orifice of the sheath is liable to occur as a result of too vigorous treatment, and a severe inflammation and swelling of these parts may take place. The same strength injections of sheep dip, peroxid of hydrogen, or potassium permanganate, as above mentioned, may be used in the vagina of the

ewes, and the external lesions treated the same way as those on the sheaths of the bucks and wethers.

At times an infection with the necrosis germ is seen in the form of abscesses containing semisolid pus and spoken of by shepherds as boils. These are very easily cured by opening them with a knife, cleaning out the pus, and applying the disinfectant and antiseptic solutions already referred to.

The warty lip form of this disease, as already mentioned, runs a course to recovery under favorable conditions in about three to four weeks, but medicinal treatment will materially aid recovery and prevent some of the cases from becoming malignant or chronic with more or less loss of tissue from ulceration. The application of lard, mutton tallow, or vaseline containing 5 per cent of a recognized sheep dip has been very beneficial after rubbing off the scabs and crusts that form around the margins of the lips and nostrils. The necrosis germ being one which thrives best without oxygen, exposure to the atmosphere will of itself prove beneficial. Pure strength coal-tar dips, peroxid of hydrogen, tincture of iodine, and 1 per cent pyoktannin have all been found efficient, but the milder remedy just before recommended has given the best results. The lesions of the lining membrane of the mouth, which sometimes accompany this disease of lambs, may be satisfactorily treated by washing the mouth with a 2 per cent chlorate of potash solution, a 3 per cent boric acid solution, or a 1 per cent creolin solution.

The German treatment, which the writer has not yet tried because it has just been published, consists in the application of 1 part of creosote and 50 parts of cod-liver, linseed, or castor oil externally, and the administration of 1 tablespoonful of this mixture internally to each lamb twice daily.

As an aid to treatment, as well as a preventive measure, it would be advisable to feed to the sheep salt which contains either sulphur in the proportion of 1 part to 12, or crude carbolic acid 1 part to 100—that is, about 4 ounces of crude carbolic acid poured upon 12 quarts of ordinary barrel salt and thoroughly mixed.

After the affected sheep have received local treatment and recovered they should be dipped in one of the recognized sheep dips prior to being turned upon uninfected pastures or premises. Recent developments strongly indicate that much territory is infected, and it is difficult to assert that any given range is entirely clean upon which to run the sheep after dipping. While the dips may destroy unprotected bacilli on the body of the sheep, they have less effect upon those germs which are protected by the grease, dirt, and yolk of the wool. Again, it is often difficult to find all infected animals within the band, and the disease appearing in them following dipping reflects unfairly upon the effects of the dip. Certain sheep-dip preparations

do not properly emulsify in alkali water, which is the only kind available in many sections, and the results from such dips are not as efficient as they should be. However, one dipping of these recovered cases must be considered from our present view point as a necessary precautionary measure.

In conclusion, it is my opinion that the place to suppress this disease is on the range, and if much inconvenience and financial loss is to be avoided in making shipments to noninfected States the individual flock master must battle with it at home, holding back all diseased or recently exposed sheep and shipping only those which remain healthy after they have been removed from infection for at least two weeks.

O

636.073
U58
B95c

GENERAL LIBRARY,
UNIV. OF MICH.
JUL 14 1910

Issued June 23, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 161.

A. D. MELVIN, CHIEF OF BUREAU.

WHEY BUTTER.

By C. F. DOANE,

Assistant Dairyman, Dairy Division.

The practicability of making whey butter as a by-product in Cheddar or American cheese factories has hitherto received but little consideration. A few attempts to manufacture whey butter have been made at different times, but apparently not with satisfactory results, and they have generally been given up at the end of the first season. Exception may be made, however, in the case of a company that was organized about two years ago in the State of New York for making whey butter on a plan modeled after the centralizer system. To carry this out a number of cheese factories were equipped with power and separators and the cream was collected by wagon, hauled to a central point, and churned.

For more than a year the Dairy Division has been interested in this subject and it has conducted an experiment under practical conditions. The plant used was a purely local affair, intended to take care of the whey and cream of but one factory. This factory, situated in Wisconsin, received a maximum daily run of 16,700 pounds of milk, which is above the average. In other respects it would be considered a good average factory with a maker who was looking out for the yield of cheese and for the best interests of the factory patrons.

EQUIPMENT OF PLANT.

The plant which was installed for the work of making the butter proved satisfactory in every way. The factory already had a boiler and a 5-horsepower engine. A gasoline engine would be just as effective. The remainder of the equipment consisted of a tank for whey, capacity 12,000 pounds; a separator, capacity 3,500 pounds per hour; a combined churn and worker, butter capacity 100 pounds;

and a rotary pump, with a capacity of 4,000 pounds per hour. There were besides a few smaller pieces of apparatus, including a small butter print, butter paddles, a packer, tin pails, and spouting to carry the whey from the cheese vats to the large receiving vat.

A room containing about 250 square feet of floor space is sufficient to hold all the machinery and the receiving tank. This room does not necessarily have to be of the best construction, but the floor should be tight, so that it can be scrubbed without dripping through. In addition to this main making room there should be refrigerator space large enough to hold a small quantity of butter and a large can of cream. A building for storing ice is also needed.

COST OF MACHINERY.

A second-hand separator was secured for our purpose and made as good as new for \$300. Other items were: Churn, \$125; tank, \$45; pump, \$25; small items, \$25; line shaft, pulleys, and labor, \$50.

The equipment purchased for this factory cost about \$800. This sum, however, does not represent the total equipment, as the factory already had the room, boiler, and engine. Where room and power are not already available the plant would cost approximately from \$1,000 to \$1,200. A portion of this cost should not be charged up wholly against the butter equipment. The engine could be used for operating mechanical agitators, which are labor savers and well worth the cost of installing in large factories, while the ice house and refrigerator could easily be worth their cost as an accommodation to the patrons and the family of the cheesemaker.

THE YIELD OF BUTTER FROM WHEY.

The amount of butter made is calculated on the basis of the amount of milk delivered—so many pounds of butter for each 1,000 pounds of milk. Some extravagant statements have been made in news items in regard to the yield of butter from whey. According to reliable information from the New York company previously mentioned which promoted this industry, the best factory secured an average of 3 pounds of butter to 1,000 pounds of milk delivered. This factory was unusually careful to save every part of the fat possible. The factory in which our experiment was conducted made almost exactly 3 pounds of butter to 1,000 pounds of milk delivered. The yield of butter for different months varies within comparatively wide limits. For June the yield was $2\frac{1}{2}$ pounds of butter per 1,000 pounds of milk, while for October it was $3\frac{1}{2}$ pounds. The variation for days is even greater. The yield in a day has fallen as low as 2 pounds and gone as high as 5 pounds of butter to 1,000 pounds of milk. The cheese was made up at this factory in the same way as adopted by most fac-

tories, and there was nothing in the methods that should increase or decrease the percentage of fat in the whey over or under the average cheese factory.

To secure the maximum yield it is necessary to save the drippings from the milled curd, otherwise a large part of the butterfat would be lost. The writer has noted one instance where there were 58 pounds of whey dripped from the milled curd of a 5,000-pound vat of milk. This tested 11 per cent of fat. In the ordinary way of making cheese an average leakage from the milled curd of a vat of 5,000 pounds of milk would be about 40 pounds, testing about 8 per cent of fat.

SEPARATING THE WHEY.

In most of the Swiss-cheese factories the whey is run into old tanks which are poorly cared for and where it is allowed to stand until the fat has risen to the top. This practice is of course to be condemned. In making whey butter it is the best practice to run the whey directly from the vats to a thoroughly sanitary tank, and it should be separated with as little delay as possible. In a large factory the separators can be started as soon as the first whey is drawn from the vat. It will usually be found necessary to use a pump for elevating the whey from the tank to the separator, in which case a pump that is easily cleaned is very desirable. Where there is much whey to separate a separator with a large capacity should be used. From our work it is apparent that any separator which will skim milk satisfactorily is also good for whey.

CHURNING WHEY CREAM.

No peculiar difficulties present themselves in churning. Naturally a very small portion of cream is received in proportion to the volume of whey running through the separator, and the cream can be churned as soon as it is separated if so desired. It is believed that from 20 to 30 per cent of starter added improves the flavor. This starter should be milk which has been allowed to sour. The whey cream may be allowed to stand a day before churning and the sour starter can be added the evening before. The starter in all cases should be sour and thick before it is put into the cream, otherwise it would be thickened by the rennet and the resulting curd would hold a large portion of the fat and carry it into the buttermilk.

The cream should be churned at a little lower temperature than cream from milk. The Wisconsin factory where our work was carried on churned below 50° F. at all times and much of the time at 45 degrees. The cream was churned until the butter granules were the size of a grain of corn, when it was washed with cold water, salted at the rate of 1 ounce of salt to a pound of butter, and worked.

[Cir. 161]

THE QUALITY OF WHEY BUTTER.

The butter made from whey is good for table use—much better, in fact, than a large part of the butter sold to the retail trade. However, the drippings from the milled curd give the butter a characteristic flavor which is difficult to describe. This flavor brings down the theoretical score somewhat, but does not seem to injure the butter for table use. Were it not for the whey from the milled curd it is probable that an expert could not distinguish whey butter from the best creamery butter, but such a large portion of the fat is in this whey from the milled curd that it would be wasteful not to save it. Whey butter is apparently a little softer than the regular creamery butter, but a number of tests showed that this was not due to excessive moisture.

The butter made in our experimental work was sold partly to patrons of the factory and local dealers, the remainder being shipped to the Chicago market. That sold to the local trade brought a little less than the best creamery butter, while the portion shipped sold for from 2 to 3 cents under the regular price for creamery butter. A few people professed not to like the whey butter, and there was and is considerable prejudice manifested against it, which is absolutely groundless. It is, in fact, very probable that the milk coming to the ordinary cheese factory is purer than the milk delivered to the average creamery in the United States.

The whey butter made in the New York factories has been selling in the eastern markets along with the regular creamery butter. Butter made from whey should be sold as "whey butter," and not simply as "butter." The butter made in the Wisconsin factory was sold as whey butter.

PROFITS IN MAKING WHEY BUTTER.

In our experimental work a careful account was kept of the butter made, the price received, and the expenditures. The expenses were as follows:

Repairs	\$25
Ice	40
Interest on investment	40
Depreciation at 10 per cent	80
Oil	5
Salt	7
Belts	9
Butter paper for pound prints	9
Total	215

Coal, 1½ cents per pound of butter made.

Labor, 2½ cents per pound of butter made.

[Cir. 161]

The cost of repairs, interest, and depreciation would be approximately the same for a factory of any size, while the cost of fuel and labor per pound of butter can be calculated for any other factory. The butter sold at an average of about 20 cents a pound.

A factory with a maximum daily run of 10,000 pounds would receive about 2,000,000 pounds of milk in a year; this would, on the basis of 3 pounds of butter for each 1,000 pounds of milk, make 6,000 pounds of butter which would have sold, on the basis above mentioned, for \$1,200. Allowing one-half of the gross income to the farmers, as is the case at the Wisconsin factory, there would remain \$600. From this must be deducted fixed charges, as calculated above, of \$215, and the charge for labor and fuel of $3\frac{1}{2}$ cents a pound on 6,000 pounds, which amounts to \$210. The total charges would therefore amount to \$425, and the year's profit for a factory of this size would consequently be \$175.

There are, however, a number of things to be considered. First, it should be stated that the labor connected with the experimental work was performed by the regular help except for two months, when a man was hired who would probably have been hired any way for one month. In fact, except in factories where the help can barely take care of the milk at the flush of the season, the regular help could handle the extra labor involved in making whey butter, as the work comes when there is not a rush with the cheese. It is probable, also, that the future will see a lessening of the popular prejudice and a greater development of the local market, which would result in better prices being realized by the factories for the butter.

It seems, therefore, that in factories having a maximum run of 10,000 pounds or more, the making of whey butter should be a profitable undertaking for both the factory and the farmer; but factories whose runs are considerably smaller than this would not be justified in undertaking the making of whey butter unless there is some different arrangement made for collecting the cream and churning, or unless the farmers are willing to take less than half the gross returns. Whatever the farmers realize from their whey butter is practically clear gain to them, and if they would take one-third of the gross income, a factory with, say, a maximum daily run of 7,500 pounds could make whey butter at a profit.

As the business is at present established in New York, the farmer, the cheese factory, and the company operating the central churning plant each get one-third of the gross income. The central churning plant furnishes separators to the factories and stands the expense of collecting the cream. The Wisconsin factory, as before stated, gives the farmer one-half. It is, therefore, apparent that the plan adopted in New York is more advantageous to the smaller cheese factories, as the fixed charges and the labor are reduced to a minimum.

ADVANTAGES TO THE FARMER FROM THE MAKING OF WHEY BUTTER.

This should be a matter of more than passing interest to farmers who deliver milk to the cheese factories and get the whey in return. There is, of course, considerable feeding value in whey, but, contrary to the opinion of some farmers, the fat contributes but little to this value, as it is present in such a small proportion. In other words, the whey would be nearly if not quite as valuable as a feed after the fat had been removed. If, therefore, this fat can be used to make butter on a profit-sharing basis between the farmer and the factory, there should be little difficulty in arriving at an understanding whereby this waste of a valuable product may be turned into a mutual benefit.

In the factories making Swiss cheese the loss of fat in the whey is comparatively high, and there is always an attempt made to save a portion of it to make butter for domestic use. But the loss of fat in making American cheese has never been considered great enough to warrant any attempt to recover it. As the whey has usually been kept in very insanitary tanks, most of this fat has appeared on the top as a dark, filthy mass that soiled the milk cans and was usually skimmed off and thrown away. Even if allowed to remain in the whey it was, as before stated, of little feeding value.

VALUE OF SKIMMED WHEY AS FEED.

The average composition of cow's milk in the cheese districts where cows are bred for milk instead of butterfat, and the average composition of whey, are about as follows:

Average composition of cow's milk (for cheese making) and whey.

Constituents.	Milk.	Whey.
	<i>Per cent.</i>	<i>Per cent.</i>
Water.....	87.4	93.0
Fat.....	8.5	.3
Casein.....	2.7	.3
Albumen.....	.7	.7
Milk sugar.....	5.0	5.0
Ash.....	.7	.7

Milk is commonly regarded as a complete food. In the making of cheese most of the casein and fat go to form the cheese, but the other constituents of the milk do not enter into the cheese, except as they are held in suspension or solution in the whey which remains in the cheese. Of this the fat can be seen to be a very small portion. Calculating on the basis of the market value of food constituents, the albumen, being the protein of the whey, would have a cash value five times greater than the fat, and the milk sugar would be worth many times the value of the fat. In view of this the oft-repeated

[Cir. 161]

objection on the part of the farmer that skimmed whey has no feeding value is erroneous. The removal of the fat, which makes up such a small percentage of the whey, in fact makes no perceptible difference in the value of the whey.

While it is true that the quantity of butterfat in whey is small and may not appear to be worth consideration, when the loss from one factory for a year is considered it amounts to a considerable sum of money. The cheese factory in which the Dairy Division has been interested paid to the farmers about \$1,000 for their share of the butter in one year, and this sum is of course practically a clear gain to the farmers. In addition to this gain the patrons of the cheese factory can buy the butter at a lower price than they can buy creamery butter shipped in and retailed from local stores.

In view of these facts the writer is decidedly of the opinion that it is to the best interests of the farmer for the cheese factories to make whey butter where the factory receives sufficient milk to warrant the expenditure for necessary space and machinery.

SUMMARY.

1. Whey butter can be made in American cheese factories at a profit to both factory owner and farmer.
2. In a factory receiving a maximum flow of milk of 10,000 or more pounds a day some profit should be made after giving one-half of the gross returns to the farmer.
3. Very little of the feeding value is removed from the whey in skimming, so that the farmer gets larger returns from the butter sold than when the fat is fed to hogs or calves.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., April 2, 1910.



636.073
U58
B95c

GENERAL LIBRARY,
UNIV. OF MICH,
SEP 21 1910

Issued September 13, 1910.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 162.
A. D. MELVIN, CHIEF OF BUREAU.

**OFFICIALS, ORGANIZATIONS, AND EDUCATIONAL INSTITUTIONS CON-
NECTED WITH THE DAIRY INTERESTS (1910).**

The accompanying lists, compiled under the direction of B. H. Rawl, Chief of the Dairy Division, contain the names and addresses of the principal officials connected with the dairy industry, and show the facilities offered in the several States for technical dairy instruction.

CONTENTS.

	Page.
United States Department of Agriculture.....	2
Work of the Dairy Division.....	3
State dairy officials.....	4
Dairy associations:	
National and international.....	8
State.....	9
Canadian.....	17
City milk producers' associations.....	17
City milk dealers' associations.....	18
Dairy instruction.....	18
Medical milk commissions in the United States and Canada.....	28
Associations of breeders of purebred dairy animals.....	31

55346°—Cir. 162—10—1

UNITED STATES DEPARTMENT OF AGRICULTURE.

JAMES WILSON, *Secretary.*

W. M. HAYS, *Assistant Secretary.*

BUREAU OF ANIMAL INDUSTRY.

A. D. MELVIN, *Chief.*

A. M. FARRINGTON, *Assistant Chief.*

DAIRY DIVISION.

B. H. RAWL, *Chief.*

HELMER RABILD, *in charge of Dairy Farming Investigations.*

B. D. WHITE, *in charge of Dairy Manufacturing Investigations.*

L. A. ROGERS, *in charge of Research Laboratories.*

GEORGE M. WHITAKER, *in charge of Market Milk Investigations.*

ROBERT MCADAM, *in charge of Renovated Butter Inspection.*

WORK OF THE DAIRY DIVISION.

The Dairy Division of the Bureau of Animal Industry, United States Department of Agriculture, is engaged in various lines of educational and research work. Information is collected and distributed concerning all branches of dairying, including the care and improvement of dairy cattle, and the production, care, and distribution of dairy products. Statistics are compiled relative to dairy organizations, dairy schools, facilities for technical instruction, state and municipal laws, development of markets, milk supply of cities, and organization of creameries and cheese factories.

The division is divided into five sections. About ninety persons are employed. •

DAIRY FARMING.

This work includes problems in the housing and feeding of dairy cattle, remodeling old barns and building new ones, construction of silos, selection and breeding of dairy herds, keeping records of the performance of individual cows, organization of cow-testing associations, and attendance at farmers' institutes and other agricultural meetings.

A special effort has been made to develop dairying in the South by cooperating with the agricultural colleges, experiment stations, and state departments of agriculture, in giving assistance to individual dairymen, conducting dairy short courses, etc.

The cow-testing associations are self-supporting associations of dairymen who organize for the purpose of determining by monthly tests the productiveness of the individual cows in their herds, with a view to improving the average production of the herd.

RESEARCH LABORATORIES.

These laboratories are concerned with the bacteriology and chemistry involved in the manufacture, handling, and distribution of all dairy products.

A study is made of the bacteria which occur in cream, and of the other factors which have an influence on the chemical changes occurring in butter during its manufacture and storage, and the relation of these changes to alterations in flavor. For the purpose of carrying on this work more efficiently, bacteriological and chemical laboratories have been equipped on the grounds of the creamery at Albert Lea, Minn. Cold-storage rooms for the work are maintained in Chicago.

Cheese investigations consist of three general lines: Soft cheese at Storrs, Conn.; Cheddar cheese at Madison, Wis.; and Swiss cheese at Albert Lea, Minn., all in cooperation with the experiment stations of the States named. A study is made of methods of manufacture, machinery, curing, storage, and markets.

Investigations are under way on the nature of the bacteria, and the changes brought about by them, in milk produced and handled under different conditions.

The division is cooperating with the Missouri Experiment Station in investigating the variation in normal milk as affected by feed. This necessitates determining the variation due to peculiarities of breed, to gestation, period of lactation, loss or gain in body weight, etc. Special study is made of the composition of butterfats, the comparative size of fat globules from milk of different breeds, the coloring matter of milk, and the proportions of caseins and albuminoids.

DAIRY MANUFACTURES.

The work of this section is almost entirely educational, the object being to put into actual practice the knowledge obtained from scientific research. By means of correspondence and by sending men into the field, assistance is given to creameries in improving methods of manufacture, preventing losses, and keeping accurate records, all of which contribute materially toward putting them on a more profitable basis.

The Dairy Division maintains offices in New York, Chicago, and San Francisco, with a butter expert in each place whose special duty it is to inspect the butter received at these markets and give helpful suggestions to the creameries where the butter is made. Inspectors also examine butter collected by state authorities for educational purposes, and investigate the general system of scoring butter in the markets.

MARKET MILK.

- This section is devoted largely to educational work for better methods in the production and handling of market milk and cream. The work is carried on by means of correspondence, lectures, demonstration-inspections, exhibitions, milk contests, and personal visits. The work is mostly performed in cooperation with local health and dairy officials. Direct assistance has been given to the health departments of 245 cities and towns. Upon request, meetings are held with milk producers, physicians, boards of health, and milk consumers generally, for the purpose of discussing problems relating to the improvement of the milk supply and milk ordinances.

The score-card system of dairy-farm inspection has been introduced in 131 cities, and as a result the inspection has been rendered much more efficient.

An important feature of educational work carried on by this section is conducting milk and cream shows, or contests, in which samples of milk and cream are entered by various producers for examination and scoring.

RENOVATED BUTTER INSPECTION.

Under the act of Congress of May 9, 1902, the Dairy Division is responsible for the inspection of renovated butter and of the factories producing the same. It is also charged with inspections of butter for export at Chicago, New York, and Boston.

The sanitary condition of renovated butter factories is rated on the basis of a score card prepared by the division, and the factories are required to maintain the standard established. The quality of the packing stock (or butter to be renovated) is also carefully examined and passed upon by the inspectors. Three men are regularly engaged in this work, and are assisted by 18 meat inspectors in cities where both meat and renovated butter inspection are carried on.

STATE DAIRY OFFICIALS.

CALIFORNIA. Secretary of state dairy bureau, F. W. Andreasen, 16 California street, San Francisco; appointed by the state dairy bureau. Chemist, Chester F. Hoyt, San Francisco; appointed by state dairy bureau. Six inspectors appointed by state dairy bureau for dairies, factories, and markets. Appropriation, \$12,500. Police work: Enforcement of the state dairy laws. The state dairy bureau consists of three members, appointed by the governor, who serve without compensation.

COLORADO. State dairy commissioner, Robert L. Cochrane, Morrison; appointed by the governor. Deputy commissioner, Dr. W. W. Yard, Denver. Inspections are made by the commissioner or deputy commissioner. Appropriation, \$2,700.

CONNECTICUT. Dairy commissioner, Hubert F. Potter; appointed by the governor. Deputy commissioner, appointed by the commissioner, Tyler Cruttenden. Three special inspectors appointed by the commissioner look after sanitary conditions of dairies and places where dairy animals are kept. Appropriation by the general assembly for salaries and expenses, \$8,300, with an addition of \$2,500 per year for the analytical work done at the Agricultural Experiment Station, New Haven.

IDAHO. State dairy, food, and sanitary inspector, James H. Wallis, Boise; appointed by the state board of health; salary, \$1,500. State chemist, Claude D. Mason; salary, \$2,000.

ILLINOIS. State food commissioner, Alfred H. Jones, Robinson; appointed by the governor. Assistant commissioner, John B. Newman, Elgin. Sixteen inspectors and six chemists appointed by the commissioner. Office, 1620 Manhattan Building, Chicago.

INDIANA. State food and drug commissioner, H. E. Barnard, Indianapolis; appointed by the state board of health. Four inspectors appointed by state board of health. Appropriation, \$30,000. Police work: Enforcement of the pure food law. Food chemist, H. E. Bishop; assistant food chemists, W. D. McAbee and Cullen Thomas.

IOWA. State food and dairy commissioner, W. B. Barney, Hampton; appointed by the governor. Deputy commissioner, B. C. Iliff, Des Moines; appointed by the commissioner. Assistant dairy commissioners, T. A. Clarke, West Bend; J. J. Ross, Iowa Falls. State dairy expert, H. G. Van Pelt. Six food inspectors and fourteen milk inspectors. Appropriation for dairy inspection, \$5,000; for food inspection and laboratory work, \$15,000; other work, \$2,000. Educational work: Institutes, scoring contests, dairymen's meetings, factory instruction. Police work: Enforcement of dairy, food, concentrated commercial feeding stuffs, etc., laws.

KANSAS. State dairy commissioner, D. M. Wilson; appointed by the board of regents of the Kansas State Agricultural College. Deputy state dairy commissioner, M. R. Alleman. Inspection of creameries, cheese factories, dairy barns, and utensils provided for. Appropriation, \$6,000. Educational work: Institutes, scoring contests, dairymen's meetings, factory instruction. Police work: Enforcement of the dairy laws.

KENTUCKY. The state food and drugs act is enforced by the experiment station, and is particularly enforced with regard to milk and dairy products. Chief of food and drug division, R. M. Allen, Lexington.

MAINE. Commissioner of agriculture, A. W. Gilman, Foxcroft. Charged by law to investigate the production, manufacture, transportation, storage, and sale of dairy products, substitutes, and imitations thereof; to enforce all dairy laws and to promote dairy interests; also to employ a dairy expert and such assistants and agents as may be necessary, who shall have control of the field work and be especially responsible for it. The work is principally educational, and consists of institutes, meetings with granges, organizing cow-testing and breeders' associations, and investigation of dairy products. State dairy instructor, Leon S. Merrill, Solon; assistant dairy instructor, R. W. Redman, Corinna, in charge of investigation of dairy products; assistant dairy instructor, C. W. Barber, Yarmouth; assistant dairy instructor, in charge field work, seed improvement division, A. S. Cook, Presque Isle.

MASSACHUSETTS. Executive officer of the dairy bureau is the secretary of the state board of agriculture. General agent state dairy bureau, P. M. Harwood, 136 State House, Boston, elected by state board of agriculture. Chemists, Dr. B. F.

Davenport, 161 Tremont street, Boston; Dr. H. C. Emerson, 177 State street, Springfield. Five inspectors, appointed by the state dairy bureau through its general agent. Inspections twice a year. Appropriation, \$8,000. Educational work: Institutes, scoring contests, dairymen's meetings, lectures and demonstrations before farmers' organizations. Police work: Enforcement of the dairy laws.

MICHIGAN. State dairy and food commissioner, Colon C. Lillie, Lansing; appointed by the governor. Deputy commissioner, N. P. Hull, Dimondale. Eight regular dairy and food inspectors, appointed by the commissioner. Inspections at intervals throughout the year. Appropriation, \$35,000; \$6,000 of yearly appropriation being set aside for special inspectors. Fees, about \$7,000 additional. Educational work: Institutes, scoring contests, dairymen's meetings, factory instruction. Police work: Enforcement of dairy and food laws.

MINNESOTA. State dairy and food commissioner, Andrew French, St. Paul; appointed by the governor. Assistant commissioner, John McCabe, St. Peter. Inspectors appointed by the commissioner; nine for butter, one for cheese, two for milk, two for herd and barn, one for canning factory, and four other food inspectors. Appropriation, \$50,000. Educational work: Scoring contests, dairymen's meetings, factory instruction, and instruction one month in the dairy course at the agricultural college. Police work: Enforcing the pure-food laws.

MISSOURI. A state and food and drug commission was created by act of the legislature May 15, 1909. The office of state dairy commissioner was created the same date. Food and drug commissioner (also acting dairy commissioner), Dr. W. P. Cutler; appointed by the governor. Deputy food and drug commissioner and analyst, J. O. Halverson, Columbia. Chemist, Dr. P. F. Trowbridge, Columbia. Six inspectors are appointed by the food and drug commissioner.

NEBRASKA. Food, drug, and dairy commissioner, Governor Ashton C. Shallenberger, Lincoln. Deputy commissioner in charge, S. L. Mains, Lincoln; appointed by the governor. State chemist, E. L. Redfern, Lincoln. Four dairy inspectors, two food and drug inspectors. Biennial appropriation, \$15,800. Office and laboratory appropriation for the biennium, \$1,500.

NEW JERSEY. Chief of the division of creameries and dairies, George W. McGuire, Trenton; appointed by the state board of health. Assistant inspectors, A. I. Goehrig, Trenton; S. S. Van Druff, Sussex; William J. Willsey, New Brunswick.

NEW YORK. Commissioner of agriculture (including dairy), Raymond A. Pearson, Albany; appointed by the governor. All other employees of the state department of agriculture are appointed by the commissioner through examination under civil service. First assistant commissioner, George L. Flanders, Albany. Assistant commissioners, Henry H. Kracke, 23 Park Row, New York; S. Brown Richardson, Lowville; E. J. Preston, Amenia; C. E. Sackett, 44 Arcade Building, Utica; C. T. Russell, Munsville; Verlett C. Beebe, Arcade; and 134 employees.

NORTH DAKOTA. State dairy commissioner, R. F. Flint, Bismarck; assistant dairy commissioner, E. H. Pierce, Bismarck; both appointed by the commissioner of agriculture and labor. Pure food commissioner, appointed by the governor. Inspections are made once a year. Appropriation for dairy inspection, \$2,500 and fees collected from licenses; appropriation for food inspection, including laboratory work, \$10,000 and fees. Educational work: Institutes, dairymen's meetings, factory instruction, and herd testing. Police work: Enforcing sanitary conditions.

OHIO. State dairy and food commissioner, Renick W. Dunlap, Columbus; elected at state election. Chief inspector, Charles H. May, Columbus. Two assistant commissioners, nine dairy and food and drug inspectors, five consulting chemists. Appropriation, \$49,570, for dairy, food, and drugs.

OKLAHOMA. The state board of agriculture is the state dairy commission according to the new law, with the provisions of the old law in force. President, J. P. Conners, state board of agriculture, Guthrie. Secretary, C. F. Barrett. Treasurer, R. F. Wilson. State dairy inspector, O. W. Holmes. Appropriation, \$5,000. Police work: Cooperation with the city authorities and the state health department in the enforcement of pure-food laws. Dairy work is partly educational. Analytical work is done at the experiment station laboratory.

OREGON. State dairy and food commissioner, J. W. Bailey, room 19, Breeden Building, Portland; elected by the people. Deputy commissioner, R. V. Williamson. Three dairy inspectors, at salaries of \$1,200 each, with an expense allowance of \$800. Appropriation, exclusive of the above, \$4,800. Educational work: Institutes.

PENNSYLVANIA. State dairy and food commissioner, James Foust, Harrisburg; appointed by the governor. Field force: Nineteen special agents. Experts: Nine chemists. Legal force: Six attorneys. Appropriation, \$180,000 for two years, which is more than covered by fees, fines, and costs collected. Police work: Enforcement of the dairy and pure-food laws.

TEXAS. Dairy and food commissioner, J. S. Abbott, Denton; appointed by the governor. Term expires July 3, 1912. Secretary, Miss Kate Casparis. Inspector R. H. Hoffman, jr.

UTAH. State dairy and food commissioner, Willard Hanson, Salt Lake City; appointed by the governor. Deputy commissioner, Heber C. Smith, Salt Lake City. Chemist, Harman Harms. Two inspectors of dairy products and other foods. Appropriation, \$11,000 for two years. Police work: Enforcement of the pure-food law.

VIRGINIA. State dairy and food commissioner, William D. Saunders, Richmond; appointed by the governor. Deputy dairy and food commissioner, Benjamin L. Purcell, Richmond. Five inspectors of dairy products and other foods. Chemical work done in the chemical laboratory of the department of agriculture and immigration of Virginia. Appropriation, \$7,500, also income from tag sales and licenses for powder manufacturers and dairy products. Educational work: Institutes, dairymen's meetings, factory instruction. Police work: Enforcing the pure-food law.

WASHINGTON. State dairy and food commissioner, L. Davies, Davenport; appointed by the governor. Deputy dairy instructor, L. W. Hanson, Seattle. Deputy dairy and food commissioner, Will H. Adams, Spokane. Deputy dairy inspectors, George S. Henderson, Pullman; F. H. Bothell, Spokane; Chemists, Elton Fulmer, Pullman; Charles W. Johnson, Seattle. All deputies are appointed by the commissioner. Appropriation for two years, \$37,120. Educational work: Institutes, dairymen's meetings, factory instruction, instruction on farm in feeding, breeding, production, and care of butter, milk, and cream; creamery inspection and instruction. Police work: Sanitary inspection.

WISCONSIN. State dairy and food commissioner, J. Q. Emery, Madison; appointed by the governor. Assistant commissioner, U. S. Baer, Madison. Second Assistant commissioner, H. C. Larson, Madison. One chemist, four assistant chemists, and eleven inspectors, appointed by the commissioner with the approval of the governor, subject to civil-service law. Two inspectors of other foods. Appropriation approximating \$50,000. Educational work: Institutes, dairy school aid, dairymen's meetings, and factory instruction. Police work: Enforcement of dairy, food, and drug laws.

DAIRY ASSOCIATIONS.

NATIONAL AND INTERNATIONAL.

National Dairy Union. Organized 1891. Membership, 25,000. Incorporated. Does not receive state aid. Object: Originally, to secure the passage of the present oleo law; since that time to assist in enforcing and defending the same and preventing its repeal. President, George L. Flanders. Vice-president, J. A. Walker. Acting secretary, S. B. Shilling. Treasurer, W. D. Hoard. Directors: W. D. Hoard, Fort Atkinson, Wis.; George L. Flanders, assistant commissioner of Agriculture of New York, Albany, N. Y.; S. B. Shilling, 154 Lake street, Chicago, Ill.; J. A. Walker, 700 South Clinton street, Chicago; James Foust, state dairy and food commissioner of Pennsylvania, Harrisburg, Pa.

National Creamery Buttermakers' Association. Organized 1891. Membership, 1,500. Not incorporated. President, J. J. Farrell, Carver, Minn. Vice-president, Lauritz Olsen, West De Pere, Wis. Secretary-treasurer, S. B. Shilling, 154 Lake street, Chicago, Ill. Executive committee: The above officers and F. W. Stephenson, Lamont, Iowa; R. F. Frary, Lapeer, Mich., with a vice-president from each State. Annual meeting, in connection with the National Dairy Show.

Association of State and National Food and Dairy Departments. Organized 1896. Membership, state and federal dairy and food-control officials who have paid annual dues. President, George L. Flanders, Albany, N. Y. First vice-president, Dr. Lucius P. Brown, Nashville, Tenn. Second vice-president, Dr. D. Harvy Dillon, New Orleans, La. Third vice-president, Andrew French, St. Paul, Minn. Secretary, Dr. W. M. Allen, Raleigh, N. C. Treasurer, James Foust, Harrisburg, Pa. Members of the executive committee, Dr. C. D. Woods, Orono, Me.; Dr. S. J. Crumbine, Topeka, Kans.; Dr. A. N. Cook, Vermilion, S. Dak., and the president and secretary. Annual meeting, New Orleans, La., November, 1910.

National Dairy Show Association. Organized 1905. Incorporated. Object: Exhibition of modern dairy machinery and appliances, dairy products, and dairy cattle, working dairies, and sanitary milk plants. Educational features: Competition in judging contests, meetings of butter and cheese makers, and a national convention of dairymen. Cooperating organizations: The Dairy Division of the United States Department of Agriculture, the agricultural colleges and experiment stations and associations of breeders of dairy cattle. Directors: The president, J. D. Nichols, Cleveland, Ohio; the vice-president, W. B. Barney, Hampton, Iowa; the secretary-manager, Prof. H. E. Van Norman, State College, Pa.; the treasurer, D. H. Jenkins, Indianapolis, Ind., together with J. A. Walker, Chicago, Ill., E. Sudendorf, Clinton, Ill., and E. K. Slater, St. Anthony Park, St. Paul, Minn. Fifth annual meeting, Chicago, Ill., October 20-29, 1910.

Official Dairy Instructor's Association. Organized 1906. Membership, the dairy instructors and investigators (of college rank) in the agricultural colleges and experiment stations, the Dairy Division of the United States Department of Agriculture and the Dominion Department of Agriculture, Canada. Object: To advance the interests of dairy instruction and investigation. President, C. H. Eckles, Columbia, Mo. Vice-president, H. E. Van Norman, State College, Pa. Secretary-treasurer, C. B. Lane, Philadelphia, Pa. Annual meeting, in connection with the National Dairy Show.

National and State Dairy Inspectors' and Instructors' Association. Organized 1907. Membership, 27. Object: To build up and improve the dairy and creamery interests of the United States as a whole, and the States severally. President, H. C. Larson, Madison, Wis. Vice-president, Helmer Rabild, Wash-

ington, D. C. Secretary-treasurer, B. D. White, Washington, D. C. Annual meeting in connection with the National Dairy Show.

Certified Milk Producers' Association of America. Organized 1908. Membership, 30. President, Stephen Francisco, Montclair, N. J. First vice-president, S. M. Shoemaker, Eccleston, Md. Second vice-president, George Wood, Wawa, Pa. Third vice-president, E. T. Gill, Haddonfield, N. J. Fourth vice-president, S. L. Stewart, Newburgh, N. Y. Secretary-treasurer, Raymond A. Pearson, Albany, N. Y.

American Association of Creamery Butter Manufacturers. Organized 1908. Membership, 55. Headquarters, Chicago, Ill. Object: To promote dairy production, butter manufacturing, butter consumption, and dairy legislation. President, J. A. Walker, Chicago. Vice-president, A. S. Hanford, Sioux City, Iowa. Secretary, George L. McKay, 644 Commercial National Bank Building, Chicago, Ill. Treasurer, W. T. S. White, Chicago, Ill. Assistant secretary, F. W. Bouska, Chicago, Ill. Annual meetings, the third Tuesday in February.

American Dairy Farmers' Association. Organized 1909. Object: To improve the dairy interests of America. President, N. P. Hull, Dimondale, Mich. Vice-president, V. P. Bailey, Tacoma, Wash. Secretary-treasurer, Helmer Rabild, Washington, D. C. Directors: J. L. Hills, Burlington, Vt.; W. J. Fraser, Urbana, Ill.; A. J. Glover, Fort Atkinson, Wis.; W. F. Schilling, Northfield, Minn.; Leon S. Merrill, Solon, Me.

National Association of Ice Cream Manufacturers. Organized 1901. President, Ross A. Woodhull, 250 Ninety-second street, Chicago, Ill. Vice-president, A. A. Chapin, Washington, D. C. Secretary, L. W. McCray, Cincinnati, Ohio. Treasurer, Arthur Hoadley, Memphis, Tenn. Annual meeting in connection with the National Dairy Show.

United Dairy Interests Association. Organized 1909. Object: To advance the general dairy interests of the country; to promote and emphasize the common interests of all breeds of dairy cattle; to advocate effective movements—legislative, educational, or otherwise—looking to the improvement of the entire industry. President, Robert Scoville. Vice-president, William T. Wells. Secretary-treasurer, Valancey E. Fuller, 150 Nassau street, New York, N. Y. Executive council is composed of one representative of each of the associations of breeders of purebred dairy animals.

American Association of Medical Milk Commissions. See page 28.

International Dairy Federation. Organized 1903. Object: Cooperation in dairy matters and discussion of leading questions of dairy interest in different countries, having especially in view the suppression of fraudulent dealing in the sale of butter and oleomargarin, fostering sanitary milk and dairy products generally, and maintaining the international association. President, Baron Peers, Nieuwburg, Belgium. Secretary-general, L. Gedoelst, Brussels, Belgium. Headquarters of the federation, 23 Rue David Desvachez 23 Brussels. The fifth international dairy congress is to be held in Stockholm, Sweden, 1911.

International Milk Dealers' Association. Organized 1907. Membership, 30. Object: The improvement of city milk supplies. President, J. D. Nichols, Cleveland, Ohio. Vice-president, Loton Horton, Slawson-Decker Company, New York City. Secretary-treasurer, B. D. White, Washington, D. C.

STATE.

ALABAMA. *Alabama State Dairy Association.* Organized 1909. Membership about 40. Not incorporated. Does not receive state aid. Object: To promote the dairy industry in the State by having one main meeting in the winter, and a
55346°—Cir. 162—10—2

summer meeting in connection with institute work, either at Auburn or other places. President, W. E. Matthews, Birmingham. Secretary-treasurer, William Hardie, jr., Alexandria. Eight vice-presidents for the different sections of the State, as follows: C. H. Cowart, Troy; J. R. Hall, Dothan; F. H. Bates, Hamburg; M. J. Barrett, Thorsby; Charles Prichett, Attalla; Charles Cleveland, Huntsville; W. L. Lee, Birmingham.

CALIFORNIA. *California Creamery Operators' Association.* Organized 1900. Membership, 250. Not incorporated. Does not receive state aid. Aided by volunteer subscriptions and by firms interested in and identified with the industry. President, C. C. Ridgway, Porterville. Vice-president, F. H. Daniels, Alameda. Secretary, J. H. Severin, Oakland. Executive committee: The above officers, together with J. R. Murphy, Fresno; W. P. Stevens, Los Angeles; and J. I. Sedgely, San Francisco.

COLORADO. *Colorado State Dairymen's Association.* Organized 1908. Charter membership, 30; present membership, 300. Is not incorporated. Does not receive state aid. President, Jo C. Elstner, 1219 Corona street, Denver. Vice-president, M. M. Sinton, 419 South El Paso street, Colorado Springs. Secretary, B. G. D. Bishopp, 1421 Pearl street, Denver. Treasurer, W. A. Groom, Boulder. Educational work: Auxiliary meetings and dairy institutes in several sections of the State, exhibits at county and state fairs, with suitable premium lists and scoring contests, the publication of the Colorado Dairymen, working for favorable dairy legislation, organizing and fostering cow-testing associations. Police work: Enforcement of the oleomargarin laws.

CONNECTICUT. *Connecticut Dairymen's Association.* Organized 1882. Membership, 488. Incorporated 1889. Receives state aid, \$1,500. President, W. H. Lee, New Haven. Vice-president, G. Warren Davis, Norwich. Secretary, J. G. Schwink, jr., Meriden. Treasurer, B. C. Patterson, Torrington.

Connecticut Creamery Association. Organized 1890. Membership, 18. Not incorporated. Does not receive state aid. President, H. H. Ellsworth, Windsor. Vice-president, F. H. Stadtmueller, Elmwood. Secretary-treasurer, John M. Williams, Manchester.

Connecticut Milch-Goat Keepers' Association. Organized 1908. President, George W. Smith, Melrose. Vice-president, Milo N. Wooding, Hamden. Secretary, Alfred Dixon, West Hartford. Treasurer, James A. Smith, Hartford.

GEORGIA. *Georgia Dairy and Live-Stock Association.* Organized 1905. Membership, 100. Not incorporated. Does not receive state aid. The state commissioner of agriculture assists in printing the reports. President, James D. Price, Farmington. First vice-president, A. M. Soule, Athens. Second vice-president, G. F. Hunnicutt, Hopeville. Secretary, M. P. Jarnagin, Athens. Treasurer, C. L. Willoughby, Sandersville. Educational work, assisted by the dairy field agent of the state experiment station.

Atlanta Dairymen's Union. Object: Local work cooperating with the state association. President, A. M. Crosby, 712 Candler Building. Secretary, T. E. Harper, R. F. D. No. 3, Atlanta.

IDAHO. *Idaho State Dairy Association.* Organized 1899. Aided by private donations. President, D. R. Hubbard, Boise. Vice-president, R. H. Thornton, Weiser. Secretary, J. H. Franson, Moscow. Treasurer, A. E. Gipson, Caldwell.

ILLINOIS. *Illinois State Dairymen's Association.* Organized 1874. Membership 500. Incorporated. Receives state aid, \$2,500. President, L. N. Wiggins, Springfield. Vice-president, Joseph Newman, Elgin. Secretary, George Caven, 154 Lake street, Chicago. Treasurer, Charles Foss, Cedarville. Educational work: Auxiliary meetings at different points in the State, one-day programmes.

Milk Producers' Institute of Illinois. Organized 1904. Incorporated. Receives state aid, \$500; other aid, exclusive of membership fees, \$500. President, D. D. Hunt, De Kalb. Vice-president, H. S. Early, Sycamore. Secretary, J. M. MacVean, 184 La Salle street, Chicago. Treasurer, L. E. Mentch, Cary. Educational work: A two-days' institute meeting at Hinkley, January, 1909.

Illinois Dairy Cattle Improvement Association. Organized 1907. Membership 25. Not incorporated. Does not receive state aid. President, A. O. Auten, Jerseyville. Vice-president, J. P. Mason, Elgin. Secretary, Charles F. Mills, Springfield. Treasurer, John Stuart, Elburn. Executive committee: T. W. Brophy, Ingleside, L. N. Wiggins, Springfield; C. J. Lindley, Greenville; E. M. Barton, Hinsdale; Charles Gilkerson, Marengo. Educational work: Dairy trains and other work by the Illinois State Dairymen's Association.

INDIANA. *Indiana State Dairy Association.* Organized 1891. Membership 145. Incorporated 1907. State aid, \$500; from the supply houses, \$200. President, D. B. Johnson, Mooresville. Vice-president, I. B. Calvin, Kewanna. Secretary-treasurer, J. D. Jarvis, Lafayette. Executive committee: The officers of the association, together with Samuel Schlosser, Plymouth; O. W. S. Warnock, Portland; James Bobbitt, Eckerty; and H. C. Wills, of the Purdue Experiment Station, Lafayette. Educational work: Annual meeting and three dairy meetings at different points in the State.

Northern Indiana Dairy and Creamery Association. Organized 1906. Membership 35. Not incorporated. Receives state aid, indirectly as auxiliary to State Dairy Association. President, W. V. Clifford, Kewanna. Vice-president, Samuel Schlosser, Plymouth. Secretary-treasurer, A. H. Compton, New Carlisle.

Southern Indiana Dairy and Cooperative Creamery Association. Organized 1906. Membership 120. Not incorporated. Does not receive state aid. President, James Bobbert, Eckerty. Vice-president, John Heitman, Holland. Secretary-treasurer, H. A. Reynolds, R. F. D. No. 2, Crothersville.

IOWA. *Iowa State Dairy Association.* Organized 1877. Membership 500. Incorporated. State aid, \$10,000. President, W. B. Barney, Hampton. Vice-president, F. W. Stephenson, Lamont. Secretary, W. B. Johnson, 1337 East Ninth street, Des Moines. Treasurer, F. L. Odell. Fieldman, H. G. Van Pelt. Educational work: Meetings at fifty to one hundred different points in the State, together with dairy specials over different railroads run for educational purposes.

Eastern Iowa Buttermakers' Association. Membership, 50. Not incorporated. Does not receive state aid. President, F. W. Stephens, Lamont. Vice-president, R. J. Erb, Masonville. Secretary, E. E. Mittlestadt, Delaware. Treasurer, J. B. Feldman, Dyersville.

North Central Iowa Buttermakers' Association. Organized September, 1902. Membership 30. Does not receive state aid. President, Charles L. Woodworth, New Hampton. Vice-president, H. E. Forrester, Fredericksburg. Secretary-treasurer, Frank Brunner, Charles City.

Farmers' Dairy Improvement Association of Southwestern Iowa. President, E. M. Bourne, Wiota. Vice-president, C. H. Matravers, Casey. Secretary, W. H. Skitt, Adair. Treasurer, H. H. Colbert, Menlo.

KANSAS. *Kansas State Dairy Association.* Organized 1888. Membership 300. Not incorporated. Does not receive state aid. Membership fees the sole source of revenue. President, T. A. Borman, Topeka. Vice-president, C. S. Graybell, Abilene. Secretary-treasurer, I. D. Graham, Topeka. Educational work: Cooperative with the farmers' institute department of the State Agricultural College.

Kansas Creamerymen's Association. Organized 1909. Membership 25. President, A. S. Kininmoth, Winfield. Vice-president, N. H. Skourup, Pittsburg.

Secretary, P. F. Edquist. Treasurer, L. E. Manley, Topeka. Object: To promote the interest of the small creameries in the State.

KENTUCKY. *Kentucky Dairy Cattle Club.* Organized 1906. Charter membership 27; present membership 250. Incorporated. Does not receive state aid. No other aid than membership fees. President, J. W. Newman, Versailles. Vice-president, E. A. Farra, Nicholasville. Vice-president, Ben McCloskey, Wakefield. Secretary-treasurer, J. J. Hooper, Lexington. Educational work: Local meetings held from time to time in different sections of the State. The club is endeavoring to build up Kentucky's dairy interests in every possible manner. Auxiliary associations: Fayette County Dairymen's Association, R. D. Collins, secretary, Lexington. Hardin County Dairymen's Association, W. A. Jenkins, secretary, Elizabethtown. Lincoln County Dairymen's Association, B. H. Van Allman, secretary, Stanford. McCracken County Dairymen's Association, S. A. Fowler, president, Paducah. Spencer County Dairymen's Association, Charles Huff, secretary, Taylorsville. Henry County Dairymen's Association, Charles Bright, secretary, Eminence.

MAINE. *Maine Dairymen's Association.* Organized 1898. Membership 200. Not incorporated. Receives state aid, \$700. President, W. G. Hunton, Readfield. Vice-president, L. E. McIntire, East Waterford. Secretary, Leon S. Merrill, Solon. Treasurer, R. Alden, Winthrop. Educational work: Annual dairy meeting and exhibits of dairy products.

Maine Creamerymen's Association. Organized 1903. Membership 25. President, W. K. Hamlin, South Waterford. Vice-president, E. L. Bradford, Auburn. Secretary, Elmer E. Harris, Skowhegan. Treasurer, J. D. McEdwards, Bangor. Annual meetings are held in connection with the Maine Dairymen's Association.

MARYLAND. *Maryland State Dairymen's Association.* Organized 1908. Membership 40. Incorporated. President, S. M. Shoemaker, Eccleston. Vice-president, A. W. Nicodemus, jr., Buckeystown. Secretary-treasurer, J. Alexis Shriver, Bel Air.

MASSACHUSETTS. *Massachusetts Creamery Association.* Organized 1895. Membership 30. Not incorporated. Does not receive state aid. President, Watson H. Wright, Easthampton. Vice-president, William Hunter, Ashfield. Secretary-treasurer, Aurret M. Lyman, Montague. Educational work: Quarterly meetings in which the State College cooperates and furnishes speakers; cow-testing associations.

MICHIGAN. *Michigan Dairymen's Association.* Organized 1885. Membership 510. Incorporated. Receives state aid, \$300; other aid, exhibition space and contributions to premium fund, \$500. President, T. F. Marston, Bay City. Vice-president, F. H. Vandenboom, Marquette. Secretary-treasurer, E. S. Powers, Ravenna. Educational work: Four auxiliary meetings each year. Annual meeting, Bay City, February 22-24, 1911.

Grand Traverse Dairymen's Association. Organized 1901. Membership 48. Not incorporated. Does not receive state aid. President, William F. Grant, R. F. D. No. 2, Traverse City. Vice-president, Frank Leshner, Mancelona. Secretary-treasurer, James Harris, R. F. D. No. 2, Traverse City.

Oceana County Dairymen's Association. Organized 1908. Object: Stimulation and development of the dairy industry throughout that section of Michigan. Meetings are held in each dairy community in the county. President, E. K. Smith, Hart. Vice-presidents, E. M. Fuller, G. O. Anderson, A. J. Kellogg, and E. B. Moore. Secretary-treasurer, Ernest B. Meyers, Hart.

MINNESOTA. *Minnesota State Dairymen's Association.* Organized 1877. Membership 850. Incorporated. Receives state aid, \$2,000 annually; \$2,000 special.

President, W. F. Schilling, Northfield. First vice-president, A. J. McGuire, Grand Rapids. Second vice-president, E. H. Eck, Cokato. Secretary, F. D. Currier, Nicollet. Treasurer, J. M. Jack, Stanton. Educational work: Local meetings of dairymen held during the year at 35 different places.

Minnesota State Butter and Cheese Makers' Association. Organized 1894. Membership 526. Incorporated in 1895. State aid, in 1909, \$494.19. President, James Pomeroy, Mapleton. Vice-president, E. O. Blomquist, Center City. Secretary, Edwin Hed, Nicollet. Treasurer, J. T. McCarty, West Concord.

Eastern Minnesota Dairymen's and Buttermakers' Association. Organized 1904. Not incorporated. Membership 153. Does not receive state aid. President, J. E. Lindberg, White Bear Lake. Vice-president, J. L. Wahlstrom, R. F. D. No. 1, Harris. Secretary, E. O. Blomquist, R. F. D. No. 1, Center City. Treasurer, A. P. Strand, Forest Lake. One vice-president for each of the eastern counties, namely, Chicago, Pine, Isanti, and Washington. Educational work: Meetings of dairymen and buttermakers at different points held under the auspices of the association for the promotion of the dairy industry and the mutual improvement of the members.

South Central Minnesota Buttermakers' and Dairymen's Association. Organized 1909. Membership 60. Not incorporated. Does not receive state aid. President, Peter Jensen, Mapleton. Vice-president, A. L. Vingel, Mankato. Secretary, T. C. Norman, Lake Crystal. Treasurer, Paul Kimble, Rapidan. Object: To help both buttermakers and dairymen to knowledge of better and more profitable methods.

Minnesota Cooperative Dairies Association. Organized 1907. Membership 109. Incorporated. Does not receive state aid. President and general manager, J. R. Morley, Owatonna. Vice-president, C. Soley, Maple Plain. Secretary, C. A. Morse, Sauk Center. Treasurer, John McClay, Hewitt. Educational work: Frequent local dairy meetings and cooperative marketing of Minnesota butter.

Red River Valley Dairymen's Association. Organized 1903. Membership 200. Not incorporated. Branch of the Minnesota State Dairymen's Association and receives a little aid from that body yearly, otherwise self-supporting. President, William Robertson,^a Crookston. Vice-president, Lewis Jensen, Clear Brook. Second vice-president, H. A. Lidenberg, Foston. Secretary, O. A. Storvick, Crookston. Treasurer, C. M. Davidson, Climax.

MISSISSIPPI. *Mississippi Live Stock and Dairy Association.* Organized by a combination of the Mississippi Live Stock Association and the Mississippi State Dairymen's Association in 1909. Membership 200. President, Dr. Tait Butler, Starkville. Vice-president, J. S. Moore, Agricultural College. Secretary, A. Smith, Agricultural College.

MISSOURI. *Missouri State Dairy Association.* Organized 1890. Membership 500. Not incorporated. Does not receive state aid. President, P. P. Lewis, Crescent. Vice-president, W. S. Dille, Holden. Second vice-president, J. E. Roberts, Bolckow. Secretary, F. L. Austin, Columbia. Treasurer, I. T. Van Note, Columbia. Proceedings of the annual meetings are included in annual report of state board of agriculture.

Missouri Butter and Cheese Makers' Association. Organized 1907. Membership 30. Not incorporated. Does not receive state aid. Some aid from the State Dairy Association. President, W. S. Dille, Holden. Vice-president, L. A. Lyon, Rockville. Secretary, L. E. Cline, 303 Waugh street, Columbia.

^a Died January 11, 1910; Lewis Jensen acting president for this year.

MONTANA. *Montana State Dairymen's Association.* Organized 1906. Membership 50. Not incorporated. Does not receive state aid. President, Elmer Metcalf, Stevensville. Vice-president, W. H. Thompson, Great Falls. Educational work: Farmers' institute two months each spring, devoted to special creamery meetings.

NEBRASKA. *Nebraska Dairymen's Association.* Organized 1885. Membership 252. Not incorporated. Receives state aid, \$1,000. President, Charles Harding, Omaha. Vice-president, W. R. Wood, Omaha. Secretary-treasurer, S. C. Bassett, Gibbon. Educational work: Farmers' institutes, cooperative testing of dairy cows.

NEW HAMPSHIRE. *Granite State Dairymen's Association.* Organized 1884. Membership 85. Incorporated. Receives state aid, \$700; annual appropriation. President, George H. Yeaton, Dover. Vice-president, W. D. Hayden, Dover. Vice-president, Arthur B. Hough, Lebanon. Secretary, C. W. Phillips, East Candia. Educational work: Aids in forming cow-testing associations.

NEW YORK. *New York State Dairymen's Association.* Organized 1877. Life members 375; annual members 225. Incorporated 1881. Does not receive state aid; self-sustaining from advertising. President, J. D. Fredericksen, Little Falls. Vice-president, E. R. Harkness, Delhi. Secretary, R. R. Kirkland, Philadelphia. Treasurer, W. E. Griffith, Madrid. Assistant secretary, L. D. Spink, Attica.

New York State Butter and Cheese Makers' Association. Organized 1909. President, C. A. Publow, Ithaca. First vice-president, H. C. Lange, New York City. Second vice-president, J. F. O'Brien, Adams. Secretary, L. D. Spink, Attica. Assistant secretary, G. C. Dutton, South Otselic. Treasurer, J. S. Smith, Warsaw. Object of this organization, to educate members to a practical knowledge of creamery and factory operation, to promote progress in the art of butter and cheese making, and care and management of creameries and cheese factories.

Western New York Butter and Cheese Makers' Association. Organized 1910. Membership 100. Object: Advancement and improvement of the cheese and dairy industry. President, M. M. Congdon, West Clarksville. Vice-president, E. L. Jones, Delavan. Second vice-president, F. M. Holmes, East Otto. Secretary, George E. Hogue, Arcade. Treasurer, C. J. Clair, Little Valley.

NORTH CAROLINA. *North Carolina State Dairymen's Association.* Organized 1905. Membership 48. Not incorporated. Does not receive state aid. President, R. L. Shuford, Newton. Vice-president, A. L. French, R. F. D., Byrdsville, Virginia. Secretary-treasurer, J. A. Conover, West Raleigh.

NORTH DAKOTA. *North Dakota Dairymen's Association.* Organized 1891. Membership about 220. Not incorporated. Does not receive state aid. President, Theo. Kahalleck, Kenmare. Vice-president, L. B. Bassett, Marion. Secretary, R. F. Flint, Bismarck. Treasurer, Alfred Gabrielson, Fargo. Assistant secretary, Gust Kruempel, La Moure. Directors: A. W. Cunningham, Grand Rapids; John C. Christenson, New Salem; A. W. Lawrence, Hebron.

OHIO. *Ohio State Dairymen's Association.* Organized 1894. Membership 285. Not incorporated. Does not receive state aid. President, A. S. Neale, Macedonia. Vice-president, L. P. Bailey, Tacoma. Secretary-treasurer, Prof. Oscar Erf, State University, Columbus. Assistant secretary, O. C. Cunningham, Columbus. Educational work: Local dairy meetings, and a central meeting.

OKLAHOMA. *Oklahoma State Dairymen's Association.* Organized 1908. Membership 60. Not incorporated. Does not receive state aid. President, J. E. Nissley, Guthrie. First vice-president, J. F. Ball, Shawnee. Second vice-president, Robert Peebley, Oklahoma City. Secretary-treasurer, Prof. Roy C. Potts, Stillwater. Educational work: Annual meeting at Stillwater, and auxiliary

organized at Oklahoma City, 1908, known as the Oklahoma County Dairy Association. President, Emil Bracht. Vice-president, Robert Peebley. Secretary, S. J. Conner, Oklahoma City.

OREGON. *Oregon Dairymen's Association.* Organized 1892. Membership 204. Not incorporated. Does not receive state aid. President, F. L. Kent, Corvallis. First vice-president, M. S. Shrock. Second vice-president, J. D. Mickle. Secretary-treasurer, Carle Abrams, Salem. W. B. Duncan, traveling dairy inspector, maintained by private subscription.

PENNSYLVANIA. *Pennsylvania Dairy Union.* Organized 1898. Membership 300. Not incorporated. Receives occasional aid from the State. President, H. M. Stokes, Hanover. Vice-president, M. T. Philips, Pomeroy. Secretary, Prof. H. E. Van Norman, State College. Treasurer, W. D. Marshall, Lyndell.

SOUTH CAROLINA. *South Carolina Live Stock Association (including Dairy).* Organized 1902. Membership 60. Not incorporated. Receives state aid, \$500. President, W. D. Byrd, Laurens. Vice-president, in charge of the department of dairy cattle, T. P. Henderson, Phoenix. Vice-president, in charge of the department of dairy manufactures, C. H. Carpenter, Easley. Secretary-treasurer, J. M. Burgess, Clemson College.

SOUTH DAKOTA. *South Dakota Dairymen's and Butter Makers' Association.* Organized 1906. Membership 150. Not incorporated. Does not receive state aid. President, E. H. Baldwin, Belle Fourche. Vice-president, C. H. Winn, Castlewood. Secretary-treasurer, A. P. Ryger, Brookings.

TENNESSEE. *Tennessee Dairy Association.* Organized 1907. Charter members 46, present membership 100. Incorporated. Does not receive state aid. President, L. R. Campbell, Nashville. Vice-Presidents: For East Tennessee, Dr. M. Jacob, Knoxville; for Middle Tennessee, J. L. Bingham; for West Tennessee, Ford N. Taylor, Memphis. Secretary-treasurer, S. E. Barnes, Knoxville.

TEXAS. *Texas State Dairymen's Association.* Organized 1894. Membership 100. Not incorporated. Does not receive state aid. President, B. F. Frasher, Cleburne. Vice-president, C. H. Alvord, College Station. Secretary-treasurer, Prof. J. L. Thomas, College Station. Educational work: The annual meeting, held each year in July at College Station with the farmers' congress of Texas; local meetings held at such times and places over the State as conditions will permit.

Texas Creameries Association. Organized 1907. Sixty active, 10 associate members. Not incorporated. Does not receive state aid. President, Prof. C. H. Alvord, College Station. Vice-president, J. F. Kline, San Antonio. Secretary-treasurer, George Adams, Austin. Board of directors: The president and secretary, with W. T. Trousdale, Yoakum; W. B. Deland, Alvin; and H. C. Hodde, Brenham.

The Tri-State Dairy Association. Organized 1910. Membership 75. Not incorporated. Does not receive state aid. President, Avery Turner, Amarillo, Tex. Vice-president, L. Gough, Hereford, Tex. Secretary-treasurer, Perry O. Grove, Amarillo, Tex.

UTAH. *Utah State Dairy Association.* Reorganized 1909. Membership 35. Not incorporated. Does not receive state aid. President, Ben R. Eldredge. Vice-president, O. B. Hansen. Secretary, L. A. Merrill, all of Salt Lake City.

VERMONT. *Vermont Dairymen's Association.* Organized 1869. Membership 640. Not incorporated. Receives state aid, \$1,000, and about \$400 from advertising. President, F. L. Davis, Hartford. Vice-presidents: William O. Blood, Norwich; W. E. Carter, Rutland. Secretary, F. H. Bickford, Bradford. Treasurer, M. A. Adams, Derby.

VIRGINIA. *Virginia State Dairymen's Association.* Organized 1907. Membership 34. Incorporated. Does not receive state aid. President, D. H. Jones, Newport News. Vice-president, W. S. Crumpecker, Roanoke. Secretary-treasurer, W. D. Saunders, Richmond.

WASHINGTON. *Washington State Dairymen's Association.* Organized 1894. Membership 175. Not incorporated. Does not receive state aid. President, W. J. Langdon, Sumner. Vice-president, D. F. Sexton, Snohomish. Secretary-treasurer, Ira P. Whitney, Pullman.

Washington Creamery Operators' and Butter Makers' Association. Organized 1907. Membership 25. Not incorporated. Does not receive state aid. President, Hazen W. Maynard, Olympia. First vice-president, E. D. Fear, North Yakima. Second vice-president, Ira Whitney, Pullman. Third vice-president, K. O. Kjomme, Shelton. Secretary-treasurer, H. L. Reid, Centralia. Educational work: Butter-scoring contests held at different times in the year.

Western Washington Dairymen's Protective Association. Organized 1908. Membership 70. Not incorporated. Receives no state aid. President, Fred J. Mess, Orillia. Secretary, Oscar Christopher, Christopher. Treasurer, Walter J. Lunn, Auburn.

WEST VIRGINIA. *West Virginia State Dairy Association.* Organized 1903. Membership 120. Not incorporated. Receives no state aid. President, J. R. Wells, Bens Run. Secretary, C. A. Lueder, Morgantown.

WISCONSIN. *Wisconsin Dairymen's Association.* Organized 1872. Membership 200. Not incorporated. Receives state aid, \$3,000. President, H. D. Griswold, West Salem. Vice-presidents, all former presidents. Secretary, A. J. Glover, Fort Atkinson. Treasurer, H. K. Loomis, Sheboygan Falls. Educational work: Some one-day meetings in the month of June. Has organized 10 cow-testing associations on the dollar plan and has several associations operating on the 50-cents plan.

Wisconsin Dairy Manufacturers' and Milk Producers' Protective Association. Organized 1907. Specific object: To look after the interests of Wisconsin creamery and dairy men in the matter of rates for transportation of cream. President, F. A. Seeber, Waterloo. Vice-president, W. A. Roach, Waterloo. Secretary, J. G. Moore, Madison. Treasurer, H. Sorge, Reedsburg. Executive committee: C. A. Atwood, Waupun; W. E. Blumenstein, Sullivan; W. Schnieder, Johnson Creek. Meets at the call of the president.

Wisconsin Buttermakers' Association. Organized 1901. Membership 425. Incorporated. Receives state aid, \$600; other aid by advertising in programmes and by contributions to premium fund. President, J. P. Sauer, East Troy. Vice-president, A. G. Puerner, Gays Mills. Secretary, Prof. G. H. Benkendorf, Agricultural College, Madison. Treasurer, S. B. Cook, Bloomer.

Wisconsin Cheesemakers' Association. Organized 1893. Membership 450. Incorporated. Receives state aid, \$600. President, J. B. McCready, Marshfield. Vice-president, A. C. Koehler, Plymouth. Secretary, U. S. Baer, 22 West Doty street, Madison. Treasurer, Patrick Wallace, Appleton. Director for three years, Jacob Karlen, Monroe; director for two years, J. W. Cross, Mauston; director for one year, J. Grootemont, Brillion.

Southern Wisconsin Cheesemakers' and Dairymen's Association. Organized 1901. Membership 450. Incorporated. Receives state aid, \$1,000 per year. President, S. J. Stauffacher, Monroe. Vice-president, Alexander Schaller, Barneveld. Secretary, Henry Elmer, Monroe. Treasurer, Dallas E. Davis, Monroe. Cheese factory instructor, Chris. Schenk, Lancaster. Educational work: Meetings with patrons of cheese factories as needed regarding cleanliness of milk, cows, and factories.

Northwestern Wisconsin Buttermakers' Association. Organized 1908. Membership 62. Not incorporated. Does not receive state aid. President, S. B. Cook, Bloomer. Vice-president, L. H. Winter, Eau Claire. Secretary, W. A. Voigt, Eau Claire. Treasurer, J. C. Miller, Augusta. Director, R. C. Gower, Rusk.

Dunn County Dairymen's and Breeders' Association. Organized 1908. Membership 70. Not incorporated. Does not receive state aid. President, E. C. Jacobs, Elk Mound. Vice-presidents, one in every township. Secretary, G. A. Gilbert, Menomonie. Treasurer, J. S. Govin, Menomonie. Object: To promote the breeding and improvement of high-grade and purebred dairy cattle, to establish and maintain cordial relations between its members, and by cooperation to promote the general dairy interests of Dunn County. Two meetings are held every year.

Dane County Buttermakers' Association. Organized 1907. Membership 55. Not incorporated. Does not receive state aid. President, H. B. Hoiberg, Brooklyn. Vice-president, O. Olsen, Mount Horeb. Secretary-treasurer, J. G. Moore, Madison.

Brown County Buttermakers' Association. Organized 1904. Not incorporated. Does not receive state aid. President, James F. McGill, Little Suamico. Vice-president, George Borchert, R. F. D. No. 4, Green Bay. Secretary, John Boerschinger, R. F. D. No. 3, Green Bay. Treasurer, Clay Tyler, West De Pere.

CANADIAN.

ONTARIO. *Eastern Ontario Dairymen's Association.* Organized 1869. Membership 300. Incorporated. Receives state aid, \$2,000 per annum, with some occasional private contributions. President, H. Glendenning, Manilla. First vice-president, J. H. Singleton, Smiths Falls. Second vice-president, T. A. Thompson, Almonte. Secretary, R. G. Murphy, Brockville. Treasurer, J. R. Anderson, Mountain View. Educational work: Special dairy meetings.

Dairymen's Association of Western Ontario. Organized 1867. Membership 330. Receives state aid, \$2,000 per annum. President, John H. Scott, Exeter. First vice-president, William Waddell, Kerwood. Secretary-treasurer, F. Hens, London. Educational work: District and patrons' meetings; work in conjunction with the Ontario department of agriculture to improve the quality of dairy products and the sanitary condition of the cheese factories and creameries of western Ontario through the employment of dairy experts as instructors; farms of patrons visited and instruction given in milk production. Chief dairy instructor for western Ontario, Frank Hens, London.

CITY MILK PRODUCERS' ASSOCIATIONS.

Chicago Milk Shippers' Union (Chicago, Ill.). Organized 1897. Membership 600. Not incorporated. Revenue from membership fees and donations. Educational work: Addresses at various points in the State by the secretary of the association; one or more meetings each year for lectures and discussions. President, J. P. Mason, Elgin, Ill. Vice-president, L. Robbins, McCool, Ind. Secretary-treasurer, H. B. Farmer, 99 Randolph street, Chicago.

Milk Producers' Association (Chicago, Ill.). Organized 1909. Membership 3,536, divided as follows: Illinois, 2,955; Indiana, 305; Wisconsin, 276. Incorporated. Does not receive state aid. Object: To promote the business interests of milk producers in the territory adjacent to Chicago. President, E. J. Fallows, St. Charles, Ill. Vice-presidents, John Gruel, Lake County, Ind.; C. E. Williams, Genoa Junction, Wis.; Ralph W. Chittenden, Gurnee, Ill. Secretary, James P. Grier, 1208 Ashland Block, Chicago. Treasurer, J. F. Martin, Antioch, Ill.

Milk Producers' Association of Maryland, Virginia, and District of Columbia. Organized 1903. Membership about 300. Incorporated. President, John Thomas, Ednor, Md. Vice-president, J. B. Diamond, Gaithersburg, Md. Secretary, T. Lamar Jackson, Silver Spring, Md. Treasurer, J. W. Roberts, Alexandria, Va.

Five States' Milk Producers' Association. Organized 1898. Membership 2,500. Object: To have a voice in fixing prices paid to producers for milk shipped to New York, Boston, and Chicago markets. President, Ira L. Snell, Kenwood, N. Y. Vice-president, O. P. Moore, Roxbury, N. Y. Secretary-treasurer, H. T. Coon, Homer, N. Y.

Boston Cooperative Milk Producers' Company. Organized 1904. Membership 2,400. Incorporated. Does not receive state aid. President, S. H. Abbott, Wilton, N. H. Vice-president, J. K. Mills, Northboro, Mass. Secretary, W. A. Hunter, 35 Stafford street, Worcester, Mass. Treasurer, Jonas Bemis, Charlton Depot, Mass. Members of the company ship milk to the Boston market.

The Dairymen's League. Organized 1907. Membership 2,200. Incorporated. Object: To have a voice in fixing prices paid to producers for milk shipped to New York markets. President, J. Y. Gerow, Washingtonville, N. Y. Vice-president, W. D. Tallman, Highland, N. Y. Secretary, Albert Manning, Otisville, N. Y. Treasurer, Lewis M. Hardin, Sussex, N. J.

Santa Monica Bay Milk Producers' Association (California). Organized 1909. Charter members 15. Object: To study sanitary conditions with a view to effecting improvement along broad and modern lines. President, W. A. Leach, Venice. Secretary, M. Low, Palms.

CITY MILK DEALERS' ASSOCIATIONS.

Philadelphia Milk Exchange (Philadelphia, Pa.). Organized 1886. Membership 150. Incorporated. President, Harry W. Scott. Vice-president, S. Abbott, Willits. Secretary, Joseph H. Gravenstine, 1537 North Twenty-third street. Treasurer, H. Dolfinger.

Consolidated Milk Exchange (New York, N. Y.). President, J. A. McBride, Sussex, N. J. Vice-president, W. B. Conklin, New York, N. Y. Secretary, Fred E. Seiler, Newark, N. J. Treasurer, Joseph Laemmle, 202 Bleeker street, New York, N. Y.

San Francisco Wholesale Dairy Produce Exchange (San Francisco, Cal.). President, W. H. Roussel. Vice-president, D. Richard Martens. Secretary, W. D. McArthur, 80-82 Merchant street. Treasurer, F. E. Booth.

South Side Milk Dealers' Business Club (3900 Wentworth avenue, Chicago, Ill.). President, John Stevenson. Vice-president, T. T. Smith. Secretary, Adolph G. Kirbach, 7237 Greenwood avenue. Treasurer, J. Gregorson.

Dairymen's Association of District of Columbia, Maryland, and Virginia. Organized 1895 as "The Milk Dealers' and Producers' Association of District of Columbia, Maryland, and Virginia; name changed May 20, 1908. Membership 20. Not incorporated. President, George B. Farquhar, 2016 Fourteenth street NW., Washington. Vice-president, W. A. Hartranft, 107 Seventh street NE., Washington. Secretary, John T. Brosius, 330 New Jersey avenue NW., Washington. Treasurer, A. S. Trundle, 246 I street NW., Washington.

DAIRY INSTRUCTION.

Most of the state agricultural colleges and some other institutions offer courses in dairying, varying in length from only a few weeks to four years. Instruction is given by lectures, laboratory practice, and work in the dairy. There are few entrance requirements to the short courses.

All of the instruction given in the short courses is offered to the students taking longer dairy courses or the full college courses in agriculture. The latter students specialize along lines in which they are most interested.

The names of the institutions at which instruction in dairying is given, the kind and amount of the work, as well as the season when offered, together with the names and addresses of instructors in charge, to whom requests for further information may be sent, are stated below:

ALABAMA. *Alabama Polytechnic Institute.* College course, dairying, sophomore year, September 6 to December 20. This work consists of two hours per week lectures and four hours per week laboratory work. Sophomore year, January 1 to March 7, four hours per week judging dairy cattle. Senior year, March 7 to June 1, two hours per week in lecture work in dairy farming. First term, September 8 to December 20. Lectures and laboratory work for senior veterinary students. Lectures twice a week. Laboratory work four hours a week. Address Prof. Dan T. Gray, Auburn.

Agricultural School of the Tuskegee Normal and Industrial Institute. (Colored.) Regular course, farm dairying two years. Short course of two weeks for farmers. Dairy extension work is carried on with the Jesup wagon, which is a traveling school of agriculture, giving dairy instruction throughout the country. Milk is purchased from farmers to encourage diversified farming. Address Prof. G. R. Bridgeforth, Tuskegee Institute.

ARIZONA. *University of Arizona.* Short course in agriculture. Dairying, second year. Production of sanitary milk on the farm, the management and care of a dairy herd, the composition and properties of milk, the manufacture of dairy products. Five hours, first semester. Four units. Address Prof. W. L. Fowler, Tucson.

ARKANSAS. *College of Agriculture of the University of Arkansas.* College course, one term, nineteen weeks, four hours per week required of all sophomores in the agricultural course. Two years' course in agriculture, sixteen weeks, twenty-eight lectures and thirty-two laboratory periods devoted to dairying. Elective courses, dairy cattle, herd formation and management, milk testing, city milk supply, butter making, cheese making, factory management, scoring butter and cheese. Work of dairy extension carried on through farmers' institutes. Address Prof. Victor A. Hooper, Fayetteville.

CALIFORNIA. *College of Agriculture of the University of California.* Regular college course, junior and senior years. Milk technology, market milk, dairy survey, dairy manufactures, creamery management, special dairy products, research work; given during second semester, arranged to allow four to six hours lectures and laboratory per week. Short courses on dairy manufactures and market milk, lectures two to three hours daily; practice in separating, pasteurizing, ripening, packing, dairy bacteriology, creamery accounting, machinery, and herd improvement. The courses for regular students of agriculture are technical and prepare the student to grasp the principles underlying the production of clean milk and its subsequent manufacture into butter, cheese, and other products. The short courses, which are designed to aid the butter maker, cheese maker, and market milkman, are less technical than the regular courses, but are useful in affording an opportunity of making and handling milk and milk products under competent instructors. All courses in dairy industry offered by the university are given at the university farm, Davis. Address Prof. H. A. Hopper, University Farm, Davis.

California Polytechnic School. Regular course in dairying, third year, two periods recitation and four periods laboratory per week for thirty-two weeks. This includes work in dairy machinery, milk testing, and butter and cheese

making. Work in judging, breeding, and feeding dairy cattle is given with the regular animal husbandry classes as follows: Breeds and judging, five periods recitation and eight periods practice per week for twelve weeks; feeding, three periods per week for twenty weeks. A four weeks' short course for the milk producer and a similar course for the dairy manufacturer is given each year. Address Prof. C. W. Rubel, San Luis Obispo.

COLORADO. *The State Agricultural College of Colorado.* College course taught in junior year; thirty-six hours of theory and thirty-six hours of practice. School of agriculture course, farm dairying, sixty hours. In addition to this work, the students in both courses get dairy live stock work, judging, feeding, etc. Extension-dairy work is handled through farmers' institutes at present. Address Prof. Charles A. Lory, President, Fort Collins.

CONNECTICUT. *Connecticut Agricultural College.* Instruction given in regular college course as follows: General dairying, fall term, three hours per week. This course consists largely of a study of milk, its composition, proper methods of handling, and laboratory practice with the Babcock test. Animal breeding, fall term, three hours per week. This course deals with the principles of breeding and the practical problems of selection, systems of breeding, and general improvement of live stock. Feeding, third year, fall term, five hours per week. Dairy breeds, fall term, two hours per week lectures, four hours per week laboratory. Practice given in judging animals, use of score card, and making out pedigrees. Dairy-herd management, winter term, three hours per week. Special attention given to the work of dairy-farm managers and to the construction and arrangement of farm buildings. Winter term, dairy investigation, four laboratory hours per week. Dairy manufactures, spring term, three lectures per week and nine hours laboratory work. Instruction in producing and marketing milk and cream and in the manufacture of butter. Short courses give special attention to modern methods of handling a city milk supply and to the manufacture of butter; instruction is also given in feeding and handling the dairy herd. Address Prof. J. M. Trueman, Storrs.

FLORIDA. *University of the State of Florida.* College course, freshman year, sixteen weeks, three hours per week. Short course, dairying, same as long course. Twelve weeks' course for farmers, two hours per week for six weeks. Dairy extension through farmers' institutes. Address Prof. J. J. Vernon, Gainesville.

Florida Agricultural and Mechanical College for Negroes. Dairy instruction is given to the high school and senior students as may be arranged throughout the school year. In this course the home dairy, its location, equipment, and source of milk supply are considered. Modern dairy apparatus in use is studied and theoretical instruction given in detail concerning all necessary dairy machinery. The art and principles of butter making, theory and practice of milk testing and milk inspection, and everyday rules of the best practice in modern dairies of any size or place are studied. The school's dairy is well equipped to afford practice to students in dairying. Address Prof. F. H. Cardozo, Agricultural Department of the Florida Agricultural and Mechanical College for Negroes, Tallahassee.

GEORGIA. *Georgia State College of Agriculture.* Seven thousand feet of space in the new agricultural building has been set aside for work in dairying. Purebred and grade herds of Jerseys and Holstein-Friesians are maintained for experimental work and teaching. The college maintains a commercial dairy so that the student has the opportunity of studying all phases of dairy work. Address Prof. Milton P. Jarnagin, Athens.

HAWAII. *College of Hawaii.* Dairy extension consists of lectures and personal visits to city dairies where advice is given by the head of the department. A

course in dairying is offered for the fall semester, beginning with September, 1910. Address Prof. B. E. Porter, Honolulu.

IDAHO. *College of Agriculture of the University of Idaho.* Department of dairying, four years' course. One year commercial course in dairying. Sophomore year, farm dairying, milk testing and inspection. Junior year, first semester, dairy bacteriology, advanced butter making; second semester, cheese making. Senior year, first semester, dairy seminar, dairy breeds and types of dairy cattle, dairy chemistry. Second semester, dairy seminar, judging dairy products, milk technology, ice cream and ices, factory management, milk production. The one-year course includes butter making, milk testing, cheese making (including American cheese and its manufacture), dairy bacteriology, scoring butter, and dairy practice, a creamery operated on a commercial scale. Farmers' short course includes work in farm dairying, milk testing and its value, feeding dairy cows. Address Prof. J. H. Frandsen, Moscow.

ILLINOIS. *College of Agriculture of the University of Illinois.* Department of dairy husbandry. Dairying required in freshman year, three hours per day, nine weeks. Elective courses: Milk, dairy cattle, feeding and care of herd, purebred herds, dairy farm management, city milk supply, dairy bacteriology, butter making, cheddar cheese, fancy cheese, factory management, development of the dairy industry. Dairy extension work, testing cows, feeding demonstrations, and creamery work. Address Prof. W. J. Fraser, Urbana.

INDIANA. *School of Agriculture of Purdue University.* Dairy school, four years' course, eight weeks' course, two weeks' course, one-week course. College course, sophomores, one semester, thirty-nine hours lectures and one hundred and seventeen hours laboratory. Juniors, two semesters, seventy-three hours lectures and two hundred and nineteen hours laboratory. Seniors, two semesters, one hundred and forty-six hours lectures and two hundred and nineteen hours laboratory. Short courses: Eight weeks' course. (a) *Farm dairy course*, one hundred and sixty-four hours lectures and one hundred and forty hours laboratory. (b) *Creamery course*, one hundred and four hours lectures and two hundred hours laboratory. Two weeks' course for advanced butter makers, thirty-eight hours lectures, thirty-eight hours laboratory. One-week course for farmers twelve hours lectures, six hours laboratory. The two weeks' short course is strictly for advanced butter makers and eight-weeks creamery students who desire to receive certificates. A one-week short course to farmers deals with economic and sanitary milk production. Dairy extension by herd tests, dairy meetings, dairy and creamery inspection, butter-scoring contests and special dairy trains. Address Prof. Otto F. Hunziker, Lafayette.

IOWA. *Iowa State College of Agriculture and Mechanic Arts.* Dairy school, four years' course, one year's course, two weeks' course. College course, freshman year, thirty-two hours lectures, thirty-two hours laboratory; sophomores, forty-eight hours lectures, ninety-six hours laboratory; juniors, sixty-six hours lectures, one hundred and twenty-eight hours laboratory; seniors, one hundred and sixty hours lectures and one hundred and sixty hours laboratory, counting credits for thesis and research. Additional elective work is offered in a one-year's course, two hours daily lectures and four hours laboratory; in a two-weeks' course, thirty-six hours lectures and forty-eight hours laboratory; a short course in butter making and farm dairying including principles and practice; dairy extension work in testing cows, organizing test associations and in institute work. Address Prof. Martin Mortensen, Ames.

KANSAS. *Kansas State Agricultural College.* Department of dairy husbandry. Four years' course, two ten-weeks' courses in dairy production, one ten-weeks' course in commercial dairying, one-week courses in dairy farming during state farmers' institute, and a series of four-day courses in cream testing. College course, dairy-

ing, second year, first term, twenty-six hours lectures and fifty-two hours laboratory. Dairy stock, second year, first term, thirteen hours lectures, twenty-six hours laboratory. The above courses are required of all students in the four-year agricultural group. Third year, first term, butter making; second term, milk production and dairy-farm management; third term, cheese and ice cream making. Fourth year, first term, experimental dairying, dairy mechanics; second term, special dairy products manufacture, feeding dairy cattle, dairy equipment; third term, milk inspection, herd management, dairy seminar. Short courses in dairying, January to March. Course in commercial dairying, January to March. The extension department is exercised in farmers' institutes, special dairy meetings, organizing test associations, assisting in construction of silos, dairy barns, and other dairy buildings. Address Prof. Ed. H. Webster, Dean and Director, Agricultural Experiment Station, Manhattan.

KENTUCKY. *The State University.* College course, dairying, offered all agricultural students, winter term, junior year, three hours lectures, six hours practice per week. Advanced dairying, winter term, senior year, two hours lectures with laboratory periods as arranged later. Short course, winter term, three hours per week class room and six hours laboratory per week. Extension work in farmers' institutes, dairy meetings, and inspection of creameries. The dairy work will be enlarged as rapidly as possible. A well-equipped farm dairy laboratory has been added to the facilities of this department. Address Prof. J. J. Hooper, Lexington.

LOUISIANA. *Southern University and Agricultural and Mechanical College.* Dairy school, two years' course; one-half the time is given to theory and one-half to practice. The course of instruction aims to prepare students to become practical dairy men and women, whether furnishing milk for city consumption or making butter. Such rations as will give the best results by feeding Louisiana products as far as practicable are studied. Address Southern University and Agricultural and Mechanical College, New Orleans, La.

Louisiana State University and Agricultural and Mechanical College. A course of lectures is given in farm dairying and full instruction in regard to running dairy machinery and the manufacture of butter and cheese. Students receive instruction in regard to characteristics of the various breeds of dairy cattle and have practice work in judging dairy stock. Lectures are given on the principles of feeding. Practice work is afforded in compounding rations and estimating the comparative value of foodstuffs. Address Prof. W. R. Dodson, Baton Rouge.

MAINE. *College of Agriculture of the University of Maine.* College course. Dairying in the junior year, first semester, two hours per week—one-half lectures, one-half practice. Second semester, two hours lectures and seven hours practice per week. Elective in senior year. School course, thirty hours lectures and seven hours practice per week during one semester. Short course, four weeks, thirty-two hours lectures and eighteen hours practice per week. Dairy extension by reading courses and lectures at farmers' institutes and grange meetings. Address Prof. P. A. Campbell, Orono.

MARYLAND. *Maryland Agricultural College.* College course, dairying, junior year, third term, ten weeks, three hours practice per week. Two years' course, third term, two hours lectures, three hours practice per week. Short course, winter, ten weeks. Dairy extension by farmers' institutes. Address President R. W. Silvester, College Park.

MASSACHUSETTS. *Massachusetts Agricultural College.* College course, junior year, thirty-six hours lectures, thirty-six hours laboratory work. Senior year, thirty-six hours lectures, thirty-six hours laboratory work. Short winter course, ten weeks. Dairy farming, creamery practice, and market milk work. Address Prof. W. P. B. Lockwood, Amherst.

MICHIGAN. *Michigan State Agricultural College.* Dairy school, four winter courses; creamery, eight weeks elementary, eight weeks advanced (open only to those who have completed the elementary course); cheese making, four weeks; farm dairying, eight weeks. College course, dairying, sophomore year, twelve weeks, one and one-half hours theory and two hours practice per week. Senior year, thirty-six weeks, five hours theory and ten hours practice per week. Address Prof. A. Crosby Anderson, East Lansing.

MINNESOTA. *College of Agriculture of the University of Minnesota.* Dairy school, creamery, cheesemaking, four weeks in winter. College course, one and one-half years' class work, one year practice. School of agriculture, six months lectures and practice work on milk production and farm dairy manufacturing. Farmers' short course, four weeks practice in judging and lectures on dairy husbandry; short course for creamery managers. Dairy extension work by lectures on dairy stock and milk production to farmers over the State, organizing test associations and the selection of dairy sires for community breeding. Address Prof. T. L. Haecker, University Farm, St. Paul.

MISSISSIPPI. *Mississippi Agricultural and Mechanical College.* College course, dairying, sophomore year, one term, eight hours per week. Junior year, one term, eight hours per week. Senior year, three terms, elective, six hours per week. Short course in farm dairying for two weeks during the summer months. Address Prof. J. S. Moore, Agricultural College.

MISSOURI. *College of Agriculture and Mechanic Arts of the University of Missouri.* College course, elements of dairying required one semester freshman year, thirty-four hours lectures, fifty-four hours practice. Elective, one hundred and two lectures and one hundred and two periods of laboratory practice in milk production and dairy manufactures. Short course, fourteen weeks beginning first week in November, two hours lectures, four hours practice per day. Dairy extension work by lectures in farmers' institutes and branch short courses and material for popular distribution. Address Prof. C. H. Eckles, Columbia.

MONTANA. *Montana State College of Agriculture and Mechanic Arts.* Dairy school, special creamery course, one month, beginning with February. College course, dairying given in freshman, junior, and senior years. Dairy work given in school of agriculture course, one-half year for each of three years. Dairy extension work in cooperation with creameries of the State with a view to improving dairy herds. Assistance at farmers' institutes in developing the dairy industry in the State, also six weeks each spring devoted to visiting creameries of the State that apply for special meetings. Address Prof. R. W. Clark, Bozeman.

NEBRASKA. *College of Agriculture of the University of Nebraska.* Dairy school, long course, twenty-four weeks, begins with November; two hours lectures and four hours practice per week. College course, first and second years, sixteen weeks each, with four hours practice and two hours lectures per week. Short course, dairying, nine weeks, beginning with January, four hours practice and two hours lectures. Dairy extension work in farmers' institutes. Address Prof. A. L. Haecker, Lincoln.

NEVADA. *College of Agriculture of the University of Nevada.* Short courses in dairying during the months of January, February, and March of each year for benefit of the ranchers. Address Director J. E. Stubbs, Reno.

NEW HAMPSHIRE. *New Hampshire College of Agriculture and the Mechanic Arts.* Dairy school, ten weeks, beginning with January, three hours laboratory and three hours recitation, daily. Four years' course; junior year, two lectures and six hours laboratory work per week for seventeen weeks. Two years' course, two lectures and six hours laboratory work per week for sixteen weeks. Several

elective courses are offered to both four and two year students. Dairy extension work: Addressing grange meetings, farmers' institutes, and organizing test associations. Address Prof. Fred Rasmussen, Durham.

NEW JERSEY. *The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts.* College course, senior year, two terms, lectures and laboratory work in dairy and milk-testing rooms, stock judging. Short courses, three months, beginning the first week in December. This course includes lectures in milk testing, butter making, stock judging, making of rations, and laboratory practice in all branches. The professors frequently lecture on dairy husbandry before farmers' institutes and other meetings. Address Prof. F. C. Minkler, New Brunswick.

NEW MEXICO. *New Mexico College of Agriculture and Mechanic Arts.* College course, dairying, second semester, sophomore year, one hour lecture, four hours practice per week. Elective for seniors, first semester, two hours lecture, two hours practice per week. Industrial course in agriculture; farm dairying, five hours per week for nine weeks. Lectures and practice, first semester, second year. Address Prof. H. H. Simpson, Agricultural College.

NEW YORK. *New York State College of Agriculture.* College courses given in the following subjects: Composition of milk, butter making, cheese making, fancy cheese making, market milk and milk inspection, elementary dairy bacteriology, dairy mechanics, advanced dairy bacteriology, dairy equipment, and business-methods investigations. These courses represent one to four hours per week each, and altogether would require more than half of a student's time for two years. The work is about one-half in the class room and one-half in the laboratories. Capacity about 200 students. Winter dairy course includes instruction in composition of milk, butter making, cheese making, fancy cheese making, market milk handling, dairy mechanics, dairy bacteriology, elementary chemistry, diseases of animals, feeds and feeding. This course begins early in December, continues twelve weeks, and requires all of the time of a student. The work consists of about three-fourths practice and one-fourth lectures and recitations. Capacity 125 students. Farm dairying given to students taking the short winter course in general agriculture, three hours per week, or one-fifth of a student's time; includes milk testing and farm butter making; two-thirds of this is practice. Capacity 75 students. Dairy extension work by correspondence and reading course lessons, cow-testing work. Address Department of Dairy Industry, College of Agriculture, Ithaca.

New York State School of Agriculture at Alfred University, Alfred. Farm dairying; first year, first term, four times a week; butter making, second year, first term, three times a week; cheese making, second year, second term, three times a week; creamery practice, third year, first term, two times a week. A school year consists of two terms of twelve weeks each. Address W. Truman Crandall, Alfred.

New York State School of Agriculture at St. Lawrence University, Canton. The course of study for 1908-9 included dairying in the second and third quarters of the first year. Address Herbert E. Cook, Dean, Canton.

NORTH CAROLINA. *The North Carolina College of Agriculture and Mechanic Arts.* College course, freshman year, spring term, thirty hours lectures, sixty hours practice; senior year, dairying, elective, six hours per week. Two-year agricultural course, first year, fall term, thirty lecture periods, ninety hours practice. Short course in general agriculture including forty periods dairying, eight weeks beginning with January. Dairy extension work by correspondence and farmers' institute work. Address Prof. John Michels, West Raleigh.

The Agricultural and Mechanical College for the Colored Race. Two years' dairy course, equally divided between theory and practice. Short course, four weeks in winter. Address Prof. E. F. Colson, Greensboro.

NORTH DAKOTA. *North Dakota Agricultural College.* College course, farm dairying, senior year, sixty hours lectures, seventy-four hours practice. Three years farm-husbandry course, sixty hours lectures, seventy-four hours practice. Short course, farm dairying, winter, ten weeks, thirty hours lectures, forty-eight hours practice. Address Prof. George L. Martin, Agricultural College.

OHIO. *College of Agriculture of Ohio State University.* Dairy school, ten weeks' course beginning January 11. Special two weeks' courses are given during January, February, and March. Special ten weeks' course in dairy farming, elective only to students in the short course in agriculture, two lecture periods and two half-day laboratory periods per week. In the two-year agricultural course, elementary dairying is required in the first term; dairy equipment, second term; farm dairying, third term, two lectures and two laboratory periods per week. College course in agriculture, dairying required first term, junior year, two lecture and two laboratory periods per week. College course, electives in junior and senior years, two lectures and two three-hour laboratory periods per week. Special work is given in the manufacture of butter, cheese, ice cream, milk condensing, etc., testing of milk and its products, dairy mechanics, and dairy equipment. Household dairying, spring term, two hours per week. Milk inspection, first term, two hours per week. Dairy extension work, one man devotes his entire time to such work. Address Prof. Oscar Erf, Columbus.

OKLAHOMA. *Oklahoma Agricultural and Mechanical College.* Department of dairy husbandry, college course; ten weeks in dairy farming, four weeks in creamery butter making. Two weeks in ice-cream making; three one-week courses in milk and cream testing; industrial butter makers' course; teachers' summer normal courses. Farm dairying required in sophomore year, seven hours per week, ten weeks' course. Elective course in advanced dairying, junior year, one term, seven hours per week. Senior course in dairying, including butter making, fall term; cheese making, business of dairying and factory management, winter term; dairy engineering and ice-cream making, spring term. Four weeks' course in creamery butter making includes lectures and text-book work, feeds and feeding, breeding, diseases, and care of dairy cattle; lectures and laboratory work on engines, boilers, ice, and refrigerating machinery; lectures and practical work in creamery bookkeeping and creamery accounting, and practical work in churning, testing, pasteurizing, and making and using starters. Two weeks' course in ice-cream making includes lectures and practical work, also receiving, sampling and weighing, and testing milk and cream. Industrial butter makers' course includes lecture work supplementing the practicum work obtained. Dairy extension work in organizing cooperative creameries, county dairy associations, cooperative circuit breeding clubs, cow-testing associations, conducting dairy institutes and butter-scoring contests. Address Prof. Roy C. Potts, Stillwater, Okla.

OREGON. *Oregon State Agricultural College.* College course in dairy husbandry, dairying in secondary, sophomore, junior, and senior years; lectures, text, and practice. Dairy school, six weeks, lectures and practice, designed for inexperienced men. Lectures and demonstration. Home dairying for domestic-science students, two credits for one semester. Address Prof. F. L. Kent, Corvallis.

PENNSYLVANIA. *The Pennsylvania State College.* College course in dairy husbandry, a total of one hundred and eighty-seven hours lectures and recitations and four hundred and forty-two hours laboratory practice during junior and senior years in butter, cheese, and ice-cream making, dairy cattle, farm and factory management, dairy cattle and product judging, market milk and inspection work. Two hours lectures and two hours practice required of all agricultural students.

Winter courses, twelve weeks, milk production, factory and farm butter, cheese, and ice-cream making, testing, judging, breeding, and feeding dairy cattle. Special work farmers' week, during the college Christmas recess. A commercial creamery and dairy herd in connection with dairy school. Extension work, herd tests, butter makers' educational contest. Address Prof. H. E. Van Norman, State College.

National Farm School, Doylestown. Dairying and practical work in butter making, four hours a week in the spring term of the sophomore year.

RHODE ISLAND. *Rhode Island State College.* College course, dairy practice, lectures and laboratory; junior year, seventy-two hours, two and one-half credits for first half year required of agricultural students; senior year, fifty-four hours, two credits second half year, elective for agricultural students in animal husbandry. Short course in agriculture, dairy practice, laboratory work, second year, first term, thirty-six hours, one credit. Address Howland Burdick, Instructor in Dairying, Rhode Island State College, Kingston.

SOUTH CAROLINA. *Clemson Agricultural College of South Carolina.* College course, dairying, junior year, seven months, four hours theory, four hours practice per week. Dairy extension work in farmers' institutes. Address Prof. D. O. Nourse, Clemson College.

The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina. Instruction in dairying and cheese making. Address President Thomas E. Miller, Orangeburg.

SOUTH DAKOTA. *South Dakota State College of Agriculture and Mechanic Arts.* Four years' dairy course leading to the degree B. S. Fifteen hours dairy lectures and fifteen hours laboratory work each week during two years; advanced dairy work in the laboratories. Three months' dairy course leading to a dairy certificate, eighteen hours lectures and daily practice in college creamery are required per week. Students may specialize in butter or cheese making or in economic milk production. Two weeks' winter course for experienced creamery men. One week cream-testing and cream-receiving course. Address Prof. C. Larsen, Brookings.

TENNESSEE. *College of Agriculture, University of Tennessee.* Dairy school, creamery, farm dairy, judging, principles of dairying, two weeks in February. College course, sophomore year, first term, principles of dairying; junior year, second term, dairy farming; senior year, first and second terms, elective dairy work. Summer school, principles of dairying, dairy practice, and dairy farming, two weeks in June. Instruction in the summer school is adapted to teachers in county and city schools with a view to creating a wider interest in dairy education. Dairy extension work by farmers' institutes and farmers' conventions held in different parts of the State. Address Dairy Department, University of Tennessee, Knoxville.

TEXAS. *Agricultural and Mechanical College of Texas.* College course, junior year, one term, twelve weeks, two hours theory and two and one-half hours practice required of all courses in agriculturture. Senior year, elective, one term, twelve weeks, three hours theory and two and one-half hours practice per week in dairy bacteriology, and two terms advanced dairying, three hours theory and two and one-half hours practice per week. Two years' course in agriculture required, one term, second year, three hours theory and two and one-half hours practice. A short course is given during the summer, six weeks immediately following the regular session, for men who expect to engage in the creamery business as managers or butter makers. Limited to twelve men. Opportunity also is afforded for practice in judging dairy cattle. Thirty hours practice per week. Address Prof. Charles H. Alvord, College Station.

UTAH. *The Agricultural College of Utah*. College course, junior year, eighteen weeks dairying, two-thirds practice, three hours per week. Senior year, first term, eighteen weeks. Short winter course for farmers and factory men, four weeks dairying, two lectures, six hours practice per day. Address Prof. T. E. Woodward, Logan.

VERMONT. *University of Vermont and State Agricultural College*. College course, dairying, senior year, four months, five hours per week, two-thirds lectures, one-third practice; short dairy course, eight weeks; experimental work. Address Prof. R. M. Washburn, Burlington.

VIRGINIA. *Virginia Agricultural and Mechanical College and Polytechnic Institute*. College course, home dairying, six weeks, nine hours per week, lectures and demonstrations. Creamery butter making, six weeks, nine hours per week, lectures and demonstrations. Cheese making, four weeks, nine hours per week, lectures and demonstrations. Dairy bacteriology, six weeks, nine hours per week, lectures and demonstrations. Apprentice course, home dairying, twelve weeks, twelve hours per week, lectures and demonstrations. Farmers' short course, in connection with general short course, one week, twenty-four hours, lectures and demonstrations. Address Prof. W. K. Brainerd, Blacksburg.

Hampton Normal and Agricultural Institute. (Colored.) Regular agricultural course, dairying, six months practice, five hours daily in stables for four months, five hours daily in creamery for two months, sixty forty-minute lectures. Special six weeks' short course, one hour daily in lectures, five hours practice in stables and creamery. Fifteen forty-minute lectures, also fifteen periods of creamery practice for all girls and boys taking academic courses. Address Prof. C. K. Graham, Director, Agricultural Department, Hampton.

WASHINGTON. *State College of Washington*. Short course in agriculture, ten weeks beginning with January. Courses offered in farm dairying, milk testing, butter and cheese making, and general dairy practice. School of Elementary Science, farm dairying, nineteen weeks, two hours per week. College course, nine courses offered covering all phases of dairying, lectures, and laboratory work extending throughout the college year. Address State College, Pullman.

WEST VIRGINIA. *College of Agriculture of West Virginia University*. College course, dairying, six courses of twelve to fourteen weeks each, one-third lectures, two-thirds practice. Two courses in advanced dairy work. Short course for farmers, winter, four weeks. Dairy extension work in dairy schools of one week each, in various counties. Address Charles A. Lueder, Instructor in Dairying, College of Agriculture, West Virginia University, Morgantown.

WISCONSIN. *College of Agriculture of the University of Wisconsin*. Dairy department: 1. Winter course, beginning with November, twelve weeks. 2. Swiss cheese course, two weeks in February. 3. Special dairy course for creamery and cheese factory operators and managers, ten days in February. 4. Summer course, March to November (any ten weeks). 5. Farm dairy course, December to March, fourteen weeks. 6. Long course, September to June each year. 7. Farmers' course, two weeks. College course required freshman year; elective during sophomore, junior, and senior years, half the time theory and half the time laboratory, covering all phases of dairying. Dairy extension work in butter and cheese scoring exhibits. Address Prof. E. H. Farrington, Madison.

Winnebago County School of Agriculture and Domestic Economy. Short winter course in dairying and one of the regular studies in the first year. Time is about equally divided between theory and practice. Address D. O. Thompson, Principal, Winneconne, Wis.

Dunn County School of Agriculture and Domestic Economy. Regular course, practical dairying and creamery management, two years, sixteen weeks each

year. This will be practical work supplemented with the necessary lectures. It is a course designed to train young men in conducting the business of dairy farming. Dairy extension work in farmers' institutes. Address Prof. F. R. Crane, Menomonie, Wis.

La Crosse County School of Agriculture and Domestic Economy, Onalaska. Dairying is one of the regular studies in the first year of a two-year course. Instruction is given in laboratory and text-book work, covering a study of milk and its composition, care of utensils, testing of dairy products, operation of dairy machinery, making of butter and cheese, marketing, and a study of bacteria with reference to its effect upon the dairy industry.

Marathon County School of Agriculture and Domestic Economy, Wausau. In the first year six weeks are devoted to the study of dairy cattle, six weeks to dairying, milk, and milk testing, and in the second year ten weeks are devoted to dairying, and milk and its products.

WYOMING. *College of Agriculture and Mechanic Arts of the University of Wyoming.* Dairying is offered in the regular four years' course. Milk and its properties, changes in dairy products due to bacteria, butter and cheese making, judging butter and cheese, dairy tests, dairy machinery. Text books. Twice a week. Elective, first semester, junior year. No short course is offered. No dairy extension work. Address Prof. A. D. Faville, Laramie.

MEDICAL MILK COMMISSIONS IN THE UNITED STATES AND CANADA.

The American Association of Medical Milk Commissions. Organized 1907. President, Dr. Milton J. Rosenau, Cambridge, Mass. Secretary, Dr. Otto P. Geier, 124 Garfield place, Cincinnati, Ohio. Treasurer, Dr. A. W. Meyers, Milwaukee, Wis.

[Arranged according to year of organisation.]

Medical Milk Commission of Essex County, New Jersey. Organized 1893. Chairman, Dr. Henry L. Coit, Newark. Secretary, Dr. Floy McEwen, 299 Belleville avenue, Newark.

New York Medical Milk Commission. Organized 1896. Chairman, Dr. L. Emmett Holt, College of Physicians and Surgeons, New York City. Secretary, Dr. John H. Huddleston, 145 West Seventy-eighth street, New York City.

Milk Commission of the Philadelphia Pediatric Society. Organized 1899. Chairman, Dr. J. P. Crozer Griffith. Secretary, Dr. Samuel McC. Hamill, 1822 Spruce street, Philadelphia, Pa.

Milk Commission of the Medical Society of the County of New York. Organized 1900. Chairman, Dr. E. K. Dunham. Secretary, Dr. Rowland G. Freeman, 211 West Fifty-seventh street, New York City.

Milk Commission of Medical Society of the County of Kings, Brooklyn, N. Y. Organized 1901. Chairman, Dr. W. A. Northridge. Secretary and Treasurer, Dr. Walter D. Ludlum, 362 Marlboro road.

Milk Commission of the Hartford County Medical Society, Hartford, Conn. Organized 1902. Chairman, Dr. Walter G. Murphy. Secretary, Dr. R. S. Starr, 75 Pratt street.

Milk Commission of the Elmira Academy of Medicine, Elmira, N. Y. Organized 1902. Chairman, Dr. C. W. M. Brown. Secretary, Dr. Rose G. Loop, 54 South Main street.

Milk Commission of the Medical Society of the County of Albany, Albany, N. Y. Organized 1902. Chairman, Dr. James P. Boyd. Secretary, Dr. Henry L. K. Shaw, 198 Washington avenue.

- Milk Commission of Hennepin County Medical Society, Minneapolis, Minn.* Organized 1902.^a Chairman, Dr. J. P. Sedgwick, 820 Donaldson Building.
- Milk Commission of the Milwaukee Medical Society, Milwaukee, Wis.* Organized 1903. Chairman, Dr. Lorenzo Boorse. Secretary, Dr. Albert W. Meyers, 141 Wisconsin street.
- St. Louis Pure Milk Commission, St. Louis, Mo.* Organized 1904. President, Dr. Albert Merrell. Secretary, Dr. A. S. Bleyer, 75 North Kings Highway.
- Milk Commission, City of Cleveland, Cleveland, Ohio.* Organized 1904. President, Samuel Mather. Secretary-treasurer, Dr. J. J. Thomas, 1110 Euclid avenue.
- Milk Commission of the San Francisco County Medical Society, San Francisco, Cal.* Organized 1905. President, Dr. Alfred B. Spaulding, 2510 Washington street. Secretary, Dr. Adelaide Brown, 2520 Sacramento street.
- Milk Commission of Sanitary Department, City of Seattle, Wash.* Organized 1905. Chairman, Dr. William G. Booth. Secretary, Dr. Philip Von Phul, Alaska Building, Seattle.
- Milk Commission of the Onondaga Medical Society, Syracuse, N. Y.* Organized 1905. Chairman, Dr. A. Clifford Mercer. Secretary, Dr. Albert S. Hotaling, 801 East Genesee street.
- Milk Commission of the Cincinnati Academy of Medicine, Cincinnati, Ohio.* Organized 1906. Chairman, Dr. Alfred Friedlander. Secretary, Dr. Otto P. Geier, 124 Garfield place.
- Milk Commission of the Suffolk District Medical Society, Boston, Mass.* Organized 1906. Chairman, Dr. John L. Morse. Secretary, Dr. Fritz B. Talbot, 171 Bay State road.
- Milk Commission of the Cambridge (Mass.) Medical Improvement Society, Cambridge.* Organized 1906. Chairman, Dr. William D. Swann. Secretary, Dr. Albert P. Norris, 760 Massachusetts avenue.
- Milk Commission of Jefferson County Medical Society, Louisville, Ky.* Organized 1906. Chairman, Dr. Cuthbert Thompson. Secretary, Dr. Ben Carlos Frazier, Ather-ton Building.
- Milk Commission of Medical Society of County of Monroe, Rochester, N. Y.* Organized 1906. Chairman, Dr. Richard M. Moore. Secretary, Dr. J. R. Williams, 290 Monroe avenue.
- Milk Commission of the Academy of Medicine, Toledo, Ohio.* Organized 1907. Presi-dent, Dr. Charles G. Chapman. Secretary, Dr. Charles W. Moots, "The Nicholas."
- Milk Commission of Los Angeles County Medical Association, Los Angeles, Cal.* Organ-ized 1907. President, Dr. Fitch C. E. Mattison. Secretary, Dr. George H. Kress, 240 Bradbury Building.
- Allegheny County Medical Milk Commission, Pittsburg, Pa.* Organized 1907. Chair-man, Dr. Ogden M. Edwards, jr. Secretary, Dr. C. C. Wholey, 201 South Craig street.
- Kansas City Pure Milk Commission, Kansas City, Mo.* Organized 1907. Chairman, Dr. George C. Mosher, 605 Bryant Building. Secretary, Dr. Max Goldman, 309 Century Building.
- Milk Commission of Wayne County Medical Society, Detroit, Mich.* Organized 1907. Chairman, Dr. R. S. Rowland. Secretary, Dr. T. B. Cooley, Fine Arts Building.
- Milk Commission of Montgomery County Medical Society, Dayton, Ohio.* Organized 1907. President, Dr. C. W. King. Secretary, Dr. A. L. Light, 1000 U. B. Building.
- Milk Commission of Jackson County Medical Society, Jackson, Mich.* Organized 1907. Secretary, Dr. H. H. Enders, Jackson State Savings Bank Building.
- Milk Commission of Akron, Akron, Ohio.* Organized 1907. Chairman, Dr. E. A. Weeks, 512 Everett Building.

^a This is the date of the "permanent commission," and continues the work of an earlier committee appointed for a similar purpose.

- Milk Commission of Chicago Medical Society, Chicago, Ill.* Organized 1908. President and chairman, Dr. C. S. Bacon, 2156 Sedgwick street. Secretary, Dr. J. W. Van Der Slice, 165 North Sixty-fourth avenue.
- Broome County Medical Milk Commission, Binghamton, N. Y.* Organized 1908. President, Le Roy D. Farnham, 42 Main street.
- Milk Commission of Galesburg, Ill.* Organized 1908. President, Dr. Benjamin D. Baird, Main street, Galesburg. Secretary, Dr. D. J. Evans, Galesburg.
- Certified Milk Commission of Bridgeport Medical Society, Bridgeport, Conn.* Organized 1908. Secretary, Dr. Charles N. Haskell, 467 State street.
- Milk Commission of Academy of Medicine of Columbus, Ohio.* Organized 1908. President, Dr. Ernst Scott. Secretary, Dr. George C. Schaeffer, 112 East Broad street.
- Canadian Medical Association Milk Commission, Toronto, Canada.* Organized 1908. Chairman, Dr. Charles J. Hastings, 258 Wellesley street.
- Milk Commission of the Greenwich Medical Society, Greenwich, Conn.* Organized 1908. Chairman, Dr. A. W. Klein. Secretary-treasurer, Dr. Edward O. Parker.
- Medical Milk Commission of Duval County Medical Society, Jacksonville, Fla.* Organized 1908. Chairman, Dr. James V. Freeman. Secretary, Dr. William Edson Ross, 602 Consolidated Building, Jacksonville.
- Milk Commission of Ocala, Ocala, Fla.* Organized 1908. Secretary, Dr. E. Van Hood.
- Milk Commission of Indianapolis Medical Society, Indianapolis, Ind.* Organized 1908. President, Dr. Charles E. Ferguson. Secretary, Dr. O. N. Torian, Willoughby Building.
- Milk Commission of Passaic County Medical Society, Paterson, N. J.* Organized 1908. President, Dr. Francis H. Todd. Secretary and treasurer, Dr. G. Edward Tuers, 12 Church street.
- Milk Commission of the Academy of Medicine, Toronto, Canada.* Organized 1908. President, Dr. Henry T. Machell. Secretary-treasurer, Dr. W. L. T. Addison, 431 Broadview avenue.
- Medical Milk Commission of Worcester, Mass.* Organized 1908. President, Dr. Charles L. Nichols. Secretary, Dr. R. J. Ward, 397 Pleasant street.
- Milk Commission of Summit County Medical Society, Akron, Ohio.* Organized 1908. President, Dr. A. F. Sippy. Secretary, Dr. E. M. Weaver, 500 Everett Building.
- Milk Commission of Kent County Medical Society, Grand Rapids, Mich.* Organized 1908. Chairman, Dr. G. McBride. Secretary, Dr. William H. Veenboer, 504 Ashton Building.
- Milk Commission of Silverbow County Medical Society, Butte, Mont.* Organized 1908. President, Dr. J. D. Freund. Secretary, Dr. C. T. Pigot, Penna Block.
- Santa Barbara Medical Milk Commission, Santa Barbara, Cal.* Organized 1908. President, Dr. William L. Holt. Secretary, Dr. Charles S. Stoddard, Fithian Building.
- Ocean County Medical Society Milk Commission, Lakewood, N. J.* Organized 1908. Chairman, Dr. William G. Schaeffer. Secretary, Dr. Irwin H. Hance, Lakewood.
- Milk Commission of Warren County Medical Society, Warren, Pa.* Organized 1908. Secretary, Dr. L. E. Chapman.
- Milk Commission of Luzerne County Medical Society, Wilkes-Barre, Pa.* Organized 1908. President, Dr. Charles Long. Secretary, Dr. Maurice Ahlborn.
- Milk Commission of Northampton County Medical Society, Easton, Pa.* Organized 1908. Chairman, Sterling D. Shimer.
- Milk Commission of El Paso County Medical Society, Colorado Springs, Colo.* Organized 1909. President, Dr. C. F. Gardiner. Secretary, Dr. Lewis Hugh McKinnie.

Union County Medical Milk Commission, Elizabeth, N. J. Organized 1909. Chairman, Dr. William H. Murray, Plainfield. Secretary, Dr. Arthur Stern, 224 East Jersey street.

Franklin County Milk Commission, Saranac Lake, N. Y. Organized 1909. President, Dr. E. R. Baldwin. Secretary, Dr. D. C. Twichell.

Milk Commission of the Galva District Medical Society, Kewanee, Ill. Organized 1909. President, Dr. H. N. Heflin.

Wheeling Certified Milk Commission, Wheeling, W. Va. Organized 1909. President, Dr. Robert J. Reed. Secretary, Dr. William H. McClain, 83 Twelfth street.

Milk Commission of Malden Medical Society, Malden, Mass. Organized 1909. Chairman, Dr. A. J. Stevens, 539 Main street. Secretary, Dr. E. W. Barron.

Milk Commission of the Alameda County Medical Society,^a Oakland, Cal. Reorganized 1909. President, Dr. Thomas C. McCleave, 2200 Bancroft way, Berkeley. Secretary, Dr. Sarah I. Shuey, 952 Fourteenth street, Oakland.

ASSOCIATIONS OF BREEDERS OF PUREBRED DAIRY ANIMALS.

The interests of the different breeds of dairy cattle are in charge of organizations of breeders, which determine purity of breeding, verify pedigrees, register eligible animals, and publish herdbooks. Some of them record and publish sales and transfers and attested records of dairy performances. They also establish standards of excellence. The details of the work are usually left to the secretary. The names of the various associations and the addresses of the secretaries are as follows:

Ayrshire Breeders' Association. Secretary, C. M. Winslow, Brandon, Vt.

Brown Swiss Breeders' Association. Secretary, C. D. Nixon, Owego, N. Y.

Dutch Belted Cattle Association of America. Secretary, G. G. Gibbs, Marksboro, N. J.

American Guernsey Cattle Club. Secretary, William H. Caldwell, Peterboro, N. H.

Holstein-Friesian Association of America. Secretary, F. L. Houghton, Brattleboro, Vt.

American Jersey Cattle Club. Secretary, J. J. Hemingway, 8 West Seventeenth street, New York, N. Y.

In addition to the strictly dairy cattle named above, some breeds, primarily developed for beef production, are occasionally bred and used as dairy cattle. Their associations are as follows:

American Devon Cattle Club. Secretary, L. P. Sisson, Newark, Ohio.

American Polled Durham Breeders' Association. Secretary, J. H. Marts, Greenville, Ohio.

Red Polled Cattle Club of America. Secretary, H. A. Martin, Gotham, Wis.

American Shorthorn Breeders' Association. Secretary, John W. Groves, 17 Exchange avenue, Union Stock Yards, Chicago, Ill.

The following breeds are of practical dairy value, although not yet officially certified as purebred:

The American Polled Jersey Cattle Club. Secretary, Charles S. Hatfield, R. F. D. 4, Springfield, Ohio.

American Milk Goat Record Association. Secretary, J. C. Darst, Dayton, Ohio.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., June 25, 1910.

^a Oakland Home Club Milk Commission, Oakland, Cal. Organized 1914.

636.015
u58
B95c

Issued August 18, 1910.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 163.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY
UNIV. OF MICH.
AUG 31 1910

THE REGENERATION OF THE MORGAN
HORSE

BY

GEORGE M. ROMMEL,

*Chief of the Animal Husbandry Division,
Bureau of Animal Industry.*



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

[Cir. 163]

(2)

51335*—10

THE REGENERATION OF THE MORGAN HORSE.^a

INTRODUCTION.

Of the three types of light horses which American breeders have developed during a century and a quarter, none stands higher in history, judged from the interest and affection which have been devoted to it, none has had a more direct and lasting influence on other types, none, in fact, has been more uniform in type, more prepotent in breeding, or more nearly a fixed breed than the Morgan horse.

With an ancestry which must have been of the highest merit, reared on the limestone and granite hills of New England, imbued with remarkable endurance and stamina by a rigorous but invigorating climate, these little horses seventy-five years ago yielded to none in popularity and held first place in the actual money value placed on individuals and on the service fees of sires. Fifty years ago Morgan stallions were received in the show rings of Kentucky with enthusiasm. Yet during the last twenty years the name of Morgan has been anathema among the horse breeders of Kentucky, the breed has been rarely seen in the show ring at state and national fairs, and the live-stock press and many horsemen of authority have declared the Morgan to be an extinct race.

CAUSES OF THE DECLINE OF THE MORGAN HORSE.

The causes of this remarkable decline in a breed of horses of outstanding merit are not difficult to discover. Up to the time that the mania for breeding extreme speed in harness horses manifested itself, the qualities of conformation, style, and endurance which the Morgan possessed were generally appreciated, and it was recognized that in the long run those qualities were worth more money than speed records. With the track records of Ethan Allen and Daniel Lambert before them, however, Morgan breeders began to think that the Morgan could be made a race horse, and the speed craze struck them. The decline of the Morgan horse may be dated from this time. It was indeed unfortunate that the old-time Morgan breeders did not follow the advice of Linsley in his book on Morgan

^a This circular is based on an address delivered before the Connecticut Valley Breeders' Association at Northampton, Mass., January 25, 1910.

horses, published in 1857.^a He foresaw with true intuition what would happen if Morgan breeders set up a speed standard. These were his words on this subject:

There are some breeders of Morgan horses who, although they will not breed from animals decidedly inferior in form, merely because they may happen to be fast, are yet inclined to lay too much stress upon great speed—a good quality, but one which we think is often purchased at the expense of qualities even more valuable.

If animals are selected for breeding which can make the best time for a mile, we think the tendency will be to depreciate the value of the breed. Bred for that one purpose, they will lose some of their compactness, become more leggy and “rangy,” and lack the stamina of the true Morgan. The general business qualities of the Morgan are what give him his great value. His admirable traveling gait, and his stoutness, courage, and endurance, are what is wanted for the road. It is not wise, therefore, to attempt to make him the fastest horse in the world, for in doing this we shall be very likely to lose sight of qualities far more important than the ability to trot a mile in 2 minutes 30 seconds.

This is exactly what happened, although even Linsley could hardly have foreseen that the effect would be almost to exterminate the breed.

When the especial value of the Hambletonian and George Wilkes lines for speed production began to be recognized, Morgan breeders resorted to crosses with them, and the Morgan soon became affected by the change in breeding methods. The desire for greater size in the Morgan found its expression in similar and even more violent crosses. As a result we have the Morgan situation of to-day—a few real Morgans fostered by breeders who were loyal to breed standards and who were not carried away by the fashion of the hour, and a very great many which trace to Justin Morgan and are registered as Morgans but are Morgans only in name. Anyone witnessing the Morgan exhibit at the horse show of the Louisiana Purchase Exposition at St. Louis in 1904 could not fail to be impressed with this fact. The real Morgan was there, but he was to a large extent obscured by the great number of ungainly, ill-assorted horses which were in type more Standardbred than anything else, but which, if entered in the Standardbred classes, would have received little attention from the judges.^b

Following up the unfortunate effects of these violent and ill-judged crosses, it is not surprising that the advocates of other breeds embraced the opportunity to deal the Morgan serious blows whenever the occasion presented itself, nor is it remarkable that, in a short space of time, prejudices arose against the breed, and, as has before been observed, many even came to believe that no such thing as a Morgan existed.

^a Linsley, D. C. *Morgan Horses*. Pp. 205-206. New York, 1857.

^b Twenty-fourth Annual Report, Bureau of Animal Industry, U. S. Department of Agriculture, p. 87.

[Cir. 163]

THE VALUE OF MORGAN BLOOD.

The great value in which the breed was held fifty and seventy-five years ago need not be pointed out in detail, but a few references may be permitted to show that this value was an actual one and was admitted by horsemen generally before breeders went speed-mad.

One of the editors of the Louisville (Ky.) Journal, who made a tour of the Northern States in 1845, made these statements regarding the Vermont Morgans:

There is no doubt whatever of this—that the breed of the Morgan horse was and is now, in the few instances where it can be found, far the best breed of horses for general use that ever was in the United States—probably the best in the world; and it is remarkable that this breed was, and is now, known by many striking peculiarities, common to nearly every individual.^a

A quotation from the American Farmers' Encyclopedia, published in 1844 in Philadelphia, runs as follows:

Perhaps the very finest breed of horses in the United States, when general usefulness is taken into consideration, is what is commonly known in the Northern and Eastern States as the Morgan horse.^b

At the United States Agricultural Society's fair, held at Boston in October, 1855, the following honors were secured by Morgan horses out of a total entry of 423 animals.^c Three premiums offered for "roadster" stallions all went to horses of Morgan descent. Four premiums were offered for stallions for general use, 4 years old and over, all of which went to Morgans. Two premiums were offered for stallions for general use, 3 years old and under 4, of which one went to a Morgan. Three premiums were offered for stallions for general use, 1 year old and under 2, of which two were awarded to Morgans. Four premiums were offered for "breeding mares and fillies," of which two were won by Morgans. Three premiums were offered for fillies 3 years old, of which a Morgan received one. Only one premium was awarded for yearling fillies, and that went to a Morgan. Four premiums were offered for trotting stallions, three of which went to Morgans.

The exhibition of the Morgan stallion Champion Black Hawk at the Florence, Ky., fair in October, 1855, caused one of the most remarkable incidents ever seen in an American show ring. The blue ribbon for best stallion 4 years old and over had been tied on a dappled-gray horse, when Black Hawk was led into the ring. The crowd immediately began to shout, "Take the ribbon off the gray horse; take it off." Accordingly, the committee did so, and placed the blue ribbon on Black Hawk. Local accounts state that no judgment of the committee was more heartily approved.^d

^a Linsley, D. C. *Morgan Horses*. New York, 1857. P. 83.

^c *Ibid.*, pp. 85, 86.

^b *Ibid.*, p. 84.

^d *Ibid.*, pp. 86, 87.

[Cir. 1863]

Hale's Green Mountain was given the highest premium at the Louisville, Ky., fair in 1853 immediately after his arrival from Vermont and after having had a severe ordeal of railroad travel and previous showing,^a in a day when conditions of travel were more severe than now.

In the present day nothing has done more to focus attention on the value of the Morgan than the record of horses of Morgan type and breeding in our show rings. In Kentucky the descendants of Blood's Black Hawk, Stockbridge Chief, and others are among the most valued horses found, and fully 10 per cent of all horses registered in the first two volumes of the American Saddle Horse Register trace in direct male line to Justin Morgan. Such horses as Drummer Boy, Blaze o'Glory, Glorious Red Cloud, Glorious Whirling Cloud (Don Edwood 27131 A. T. R.), Glorious Thundercloud (Carmon 32917 A. T. R.), and Lord Baltimore are known to carry Morgan blood in their veins, and an examination of the breeding of the carriage horses of American breeding seen in our show rings will almost invariably show Morgan crosses.^b

Against all the pressure which has been driving the Morgan out of existence, the intrinsic merit of the breed has stood out in sufficient strength to make possible its regeneration if wise and broad-minded policies are adopted.

It is a matter for congratulation that the decline of the Morgan has been checked and that measures are now under way which, if wisely conducted, will in time firmly establish the breed beyond possibility of extinction. Too much credit can hardly be given the men who have preserved the type and the blood, giving us thereby the material from which to develop the modern Morgan.

THE MORGAN OF HISTORY.

Before discussing the best methods to adopt to restore the Morgan breed and place it on a firm foundation, we should consider briefly some of the salient points in its history, so as to learn, first, what the ancient Morgan type was like, and, second, what of its characteristics are worth preservation as being suitable for modern requirements.

For information concerning the ancient Morgan type there is no authority higher than D. C. Linsley. In an exceedingly painstaking and thorough manner Linsley, over fifty years ago, made a study of Morgan history and pedigrees, which is to this day the standard authority on the history of the breed up to the time of its publication in the year 1857. No one can claim to be an authority on the breed

^a Linsley, D. C. *Morgan Horses*. New York, 1857. P. 67.

^b See Twenty-fourth Annual Report, Bureau of Animal Industry, U. S. Department of Agriculture.

[Cir. 163]

without having mastered Linsley's volume; and without Linsley as the pioneer, Battell's great work would have been well-nigh impossible of achievement. Linsley's "Morgan Horses" is, indeed, "the Morgan Bible." Therefore it is largely to its pages that we turn to learn the characteristics of the Morgan of the early day.

THE JUSTIN MORGAN HORSE.

Linsley's description of the original Justin Morgan is extremely important in view of the fact that many persons believe that the regeneration of the Morgan breed at this time should have as its basic motive the restoration of the ancient Morgan type, which means, on final analysis, that the ultimate aim of the movement is to make all Morgan horses conform as nearly as possible to the type of the original Justin Morgan.

The following somewhat lengthy quotation is taken from Linsley's chapter on "Memoir and Description of the Justin Morgan:"^a

The original, or Justin Morgan, was about 14 hands high and weighed about 950 pounds. His color was dark bay, with black legs, mane, and tail. He had no white hairs on him. His mane and tail were coarse and heavy, but not so massive as has been sometimes described; the hair of both was straight and not inclined to curl. His head was good, not extremely small, but lean and bony, the face straight, forehead broad, ears small and very fine, but set rather wide apart. His eyes were medium size, very dark and prominent, with a spirited but pleasant expression, and showed no white around the edge of the lid. His nostrils were very large, the muzzle small, and the lips close and firm. His back and legs were perhaps his most noticeable points. The former was very short; the shoulder blades and hip bones being very long and oblique, and the loins exceedingly broad and muscular. His body was rather long, round and deep, close ribbed up; chest deep and wide, with the breastbone projecting a good deal in front. His legs were short, close jointed, thin, but very wide, hard and free from meat, with muscles that were remarkably large for a horse of his size, and this superabundance of muscle exhibited itself at every step. His hair was short, and at almost all seasons soft and glossy. He had a little long hair about the fetlocks, and for 2 or 3 inches above the fetlock on the back side of the legs; the rest of the limbs were entirely free from it. His feet were small but well shaped, and he was in every respect perfectly sound and free from any sort of blemish. He was a very fast walker. In trotting his gait was low and smooth and his step short and nervous. He was not what in these days would be called fast, and we think it doubtful whether he could trot a mile much, if any, within four minutes, though it is claimed by many that he could trot it in three.

Although he raised his feet but little, he never stumbled. His proud, bold, and fearless style of movement and his vigorous, untiring action have, perhaps, never been surpassed. When a rider was on him he was obedient to the slightest motion of the rein; would walk backwards rapidly under a gentle pressure of the bit and moved sideways almost as willingly as he moved forward; in short, was perfectly trained to all the paces and evolutions of a parade horse; and when ridden at military reviews (as was frequently the case), his bold, imposing style and spirited, nervous action attracted universal attention and admiration. He was perfectly gentle and kind to handle and loved to be groomed and caressed, but he disliked to have children about

^a Linsley, D. C. *Morgan Horses*. New York, 1857. Pp. 131-143.
[Cir. 183]

him and had an inveterate hatred for dogs—if loose, always chasing them out of sight the instant he saw them.

When taken out with halter or bridle he was in constant motion and very playful. He was a fleet runner at short distances. * * *

Among many races of this description that he ran were two, in 1796, at Brookfield, Vt., one with a horse called Sweepstakes, from Long Island, and the other with a horse called Silver Tail, from St. Lawrence County, N. Y. Both of these he beat with ease. Mr. Morgan (who then owned him) offered to give the owner of Silver Tail two more chances to win the stake, which was \$50, by walking or trotting the horses for it, which was declined. * * *

In harness the Justin Morgan was quiet but full of spirit, an eager and nimble traveler but patient in bad spots; and although for a long time steadily engaged in

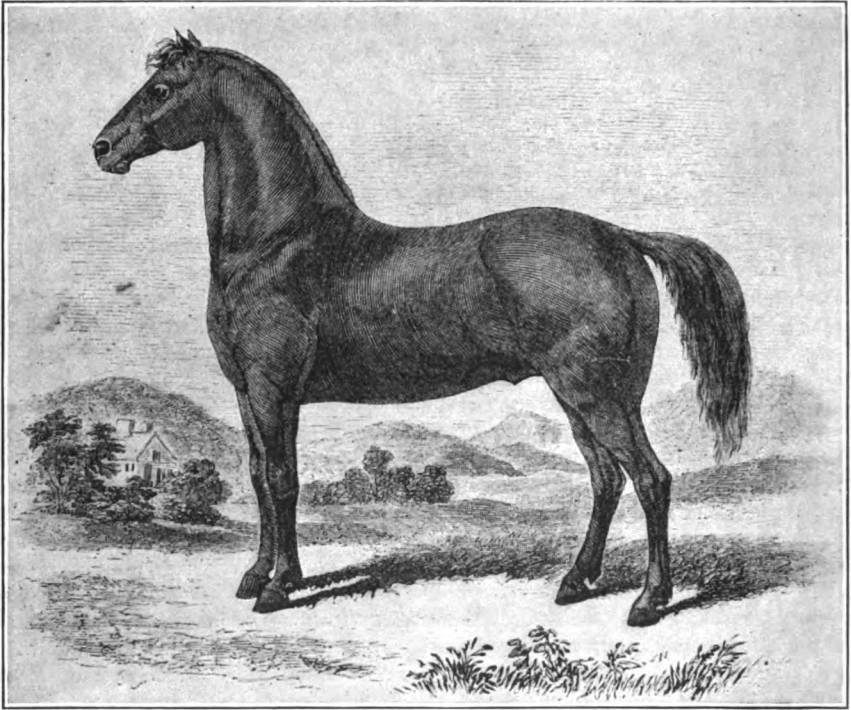


FIG. 1.—The original Justin Morgan. (From Linsley's "Morgan Horses.")

the heavy work of a new farm, his owner at that time informs us that he never knew him refuse to draw as often as he was required to, but, he pithily adds: "I didn't very often have to ask him but once, for whatever he was hitched to generally had to come the first time trying." This uniform kindness at a pull was one of the striking characteristics of the horse, and the same trait may be observed in the greater part of his descendants. "Pulling matches" and "pulling bees" were as common in those days as short races, and the "little horse," as he was often called, became quite celebrated for his unvarying willingness to do his best and for his great power at what is called a "dead lift." * * *

The quietness and exceedingly pleasant temper of the Justin Morgan is strikingly evidenced by the fact that he was often ridden and driven by ladies. A lady of St.

[Cir. 183]

Johnsbury once told us she remembered his appearance perfectly and had repeatedly ridden him, when a girl, to balls and other parties, and spoke with much enthusiasm of his noble appearance, his high spirit, and perfect docility.

It is exceedingly difficult to obtain accurate information respecting the changes in owners that occurred to the horse at different times. To account for this uncertainty, we must consider that his fame has been almost entirely posthumous; that although the champion of his neighborhood, he was little valued on account of his small size; and it was not until after his death and his descendants were exhibiting the powers of their sire, in speed, strength, and endurance in almost every village in eastern Vermont, that people began to realize they had not properly appreciated him. * * *

At 29 years of age, no cause need be assigned for his death but the ravages of time and the usual infirmities of years; but old age was not the immediate cause of his death. He was not stabled, but was running loose in an open yard with other horses, and received a kick from one of them in the flank; exposed without shelter to the inclemency of a northern winter, inflammation set in and he died. Before receiving the hurt which caused his death he was perfectly sound and entirely free from any description of blemish. His limbs were perfectly smooth, clean, free from any swelling, and perfectly limber and supple. Those persons who saw him in 1819 and 1820 describe his appearance as remarkably fresh and youthful. Age had not quenched his spirit nor damped the ardor of his temper; years of severest labor had not sapped his vigor nor broken his constitution; his eye was still bright and his step firm and elastic.

Justin Morgan's good qualities were transmitted not only to his sons but to their sons and grandsons to such a degree that where proper matings were made, according to the type, Linsley found young colts that closely resembled him "in all respects except size, in which there has been a decided increase."^a

The horse possessed that essential qualification of a great sire—impressiveness. His blood "bred on," destined to found a family and a breed. Such a sire was Hambletonian, such was George Wilkes, such were Denmark and the Darley Arabian.

THE MORGAN OF LINSLEY'S DAY.

The Morgan horse of Linsley's time was far more common than the Morgan of to-day, although the breed was even then beginning to be affected by the tendencies which in a comparatively short time threatened it with extinction. The small size of the original Morgan was undoubtedly objectionable, but, in Linsley's opinion, it was being improved in his time. He gives the height of six grandsons of Justin Morgan as ranging from 13.3 to 15 hands, with weights varying from 1,000 to 1,075 pounds, and states that 22 Morgan stallions exhibited at the United States Agricultural Society's show held in Boston in October, 1855, averaged 1,040 pounds in weight. This Linsley regards as a fair average of the Morgans of his time and as proof that the size of the breed had been increased.^b

^a Linsley, D. C. *Morgan Horses*. New York, 1857. P. 146.

^b *Ibid.*, pp. 179, 180.

[Cir. 163]

A further quotation from Linsley on the size of Morgans fifty years ago is both important and interesting.^a

The average height of Morgan horses may be stated at from 14 to 15½ hands. There are a few that will fall below 14 hands, but the number is very small, and there are also some that will exceed 15½ hands, but it is by no means common, and in such cases it will generally be found that the animal has but a small amount of Morgan blood. Their weight may be stated to range from 900 to 1,100 pounds, the usual weight being about 1,000; any great deviation from this weight should induce the suspicion of a large infusion of other blood, although exceptions may and doubtless do occur, in the case of animals that can show a good pedigree; still they must be considered as the exception to the rule, and not the rule itself.

BEST METHODS TO REVIVE THE BREED.

In view of the widespread belief that the Morgan breed should be revived and made once more an important factor in the horse industry, it is not surprising that opinions differ as to the best methods to adopt for this purpose. There is little if any question that the revival of the breed can be accomplished; enough material of the type, fixed by inheritance, is available for this. The question seems to be whether an exact revival of the ancient Justin Morgan type should be attempted, or whether we should take the best of the ancient type, improve it, and make it conform as closely as possible to modern requirements.

SHOULD THE JUSTIN MORGAN TYPE BE ADOPTED?

Let us consider again the qualities which made Justin Morgan and his sons famous. A further reference to Linsley shows that the qualities of Justin Morgan which he regarded as worth preserving are largely the qualities that make the Morgan valuable to-day, and the faults which the horse had would be regarded as faults to-day when found in Morgans. "His compactness of form, his high and generous spirit, combined with the most perfect tractability; his bony, sinewy limbs, his lofty style, and easy but vigorous action"^b are all points of value. Every one of these is admitted by horsemen as fundamental, with the possible exception of the action, on which there is a difference of opinion, some breeders wanting the highest and most brilliant action possible and others simply "easy but vigorous action." Justin Morgan's prepotency as a sire was an asset of the highest value; that also is universally regarded as fundamental in a sire.

The qualities generalized above are, in the writer's opinion, the qualities of Justin Morgan which should be perpetuated in the modern Morgan, with the single exception that the writer confesses to a desire for higher and more brilliant *natural* action than had the original

^a Linsley, D. C. Morgan Horses. New York, 1857. Pp. 70, 71. ^b Ibid., p. 146.

[Cir. 163]

Morgan. Linsley asserts that although Justin Morgan raised his feet but little, he never stumbled;^a nevertheless he recognizes the fact that a horse that was very low in action was likely to stumble, and remarks upon the sure-footedness of the original Justin Morgan in spite of this handicap. This sure-footedness is a present Morgan characteristic, but one can not be certain that the sure-footedness will always be present when handicapped by very low action.

Justin Morgan "had a little long hair about the fetlocks and for 2 or 3 inches above the fetlocks on the back side of the legs."^b Linsley congratulates the Morgan breeders of his time that "the present Morgans have not so much of the long hair of the Justin Morgan on their legs. This is an improvement, as the long hair on the legs is unsightly, inconvenient, and in no sense useful."^c One still sees this peculiarity occasionally, but no case comes to mind where a Morgan which has it is more highly valued on that account, even by the most enthusiastic advocates of the "ancient" type.

Linsley also explains the greater size of Morgan mares in districts remote from market as due to the fact that buyers had not reached such localities to purchase the larger mares. He deplores the fact that farmers allowed themselves to be tempted by high offers to sell the largest mares.^d

That we should adopt the original "ancient" Morgan type in its entirety seems little short of folly. Linsley himself admitted that Justin Morgan possessed faults; he was too good a horseman to imagine that such a thing as an absolutely perfect horse ever existed, and he warned breeders not only to avoid breed faults, but by intelligent breeding to improve and add to the breed's good qualities. .

THE IMPROVED TYPE MUST CONFORM TO MARKET REQUIREMENTS.

The writer has no intention of drawing a ridiculous picture of the original Morgan horse. He merely desires to point out the mistake which would occur if well-meaning people succeed in perpetuating manifest faults. Justin Morgan's good qualities far outweighed his poor ones, yet it is doubtful if a competent judge would consider him in a modern show ring. His small size, the hair on the fetlocks, and his low action would be regarded as objectionable by any fair-minded critic. It is no discredit to the horse to say this. He belonged to his time and he filled his niche. It was by his prepotency, his influence as a sire, that he created a place in horse husbandry. But if Justin Morgan were reincarnated to-day he could not fill this place. In short, the blood of the horse, as shown in his descendants, is greater than the horse himself, and the story of

^a Linsley, D. C. *Morgan Horses*. New York, 1857. P. 132. ^c *Ibid.*, p. 181.

^b *Ibid.*, p. 132.

^d *Ibid.*, p. 208.

[Cir. 163]

Justin Morgan is a repetition of that of almost every other great sire known to the breeders of live stock.

Let us illustrate this point in the history of another breed. The Percherons of fifty years or more ago were mainly quick-moving, light-draft horses, known in France as "diligence" horses, and were largely used to draw stage and mail coaches. Indeed, the earliest American writer on the Percheron horse used them to draw heavy carriages.^a DuHaÿs himself advocated keeping pure the three types of the original Percheron horse—the light-draft type, the heavy-draft type, and the intermediate type.^b Yet what consideration would be shown a light-draft Percheron, or even one of the intermediate type, in our modern show rings? The improvement of the breed has carried its standard as a draft horse far beyond that of its progenitors. Yet who may deny the debt the breed owes to the good qualities of those progenitors?

Again, the forebears of our modern Hereford cattle were huge animals, often gray-faced and speckled-faced, with a very heavy forehead and light hindquarters, but they were wonderful grazers. The type was one which would cause laughter if seen in a modern show ring, but who doubts that the remarkable vitality and good grazing qualities of the modern American Hereford are due to inheritance from the now obsolete type from which it descended?

It is so in breeding live stock of any kind. Improvement must be made, or the breed dies out. Breeders must set for their ideals higher standards than those of the past or even of the present, or retrogression is inevitable. Linsley held similar views and counseled breeders to improve their Morgans. At the time he wrote he says that "it can hardly be questioned that a general improvement has been steadily going on in the character of our horses."^c

Improvement should be carried out, however, in such a manner that the good qualities may be retained and the undesirable ones eliminated. To adopt size in Morgans as the one great thing to be obtained would be as unwise as to adopt the exact type of Justin Morgan or to set up extreme speed as the sole standard. Linsley, referring to this subject, recommends that the Morgan be brought up to the standard of size which he set forth (14 to 15.2 hands, weighing from 900 to 1,100 pounds), but not at the sacrifice of any of the valuable qualities already present.^d

The improved type of the Morgan horse must be based on standard market requirements for horses known in our show rings by the

^a W. T. Walters, of Baltimore, who translated Charles DuHaÿs's work on "The Percheron Horse" for the Orange Judd Company in 1867.

^b See Walter's translation.

^c Linsley, D. C., *Morgan Horses*, p. 182.

^d *Ibid.*, p. 214.

[Cir. 163]

somewhat misleading term of "heavy-harness horses." This does not mean a draft horse, as many think, but may be roughly defined as a horse which wears the heavy harness used in drawing a gig, phaeton, victoria, or similar vehicle, as distinguished from the light harness with breast strap collar used in drawing a road wagon. The type is a horse of stylish carriage, good length of neck, sloping shoulders, high withers, short, close-coupled back, full hips and quarters, high set, smartly carried tail, and round, compact conformation, with an abundance of quality and finish and as much natural action, endurance, and speed as possible; the action at the walk should be rapid, straight, and true, and nothing but pure trotting action should be tolerated, without the least tendency to pace. The Morgan should not under any circumstances be made a race horse; that experiment was tried once, and should now be considered an almost disastrous failure and the incident closed; but the endurance of the Morgan and his ability to stand driving for long distances at a smart pace are highly desirable qualities and should be preserved. It is doubtful if the Morgan will ever be a producer of brougham horses, except by crossing.

BREEDING METHODS.

The methods of breeding used to bring about the regeneration of the Morgan type will need to be very carefully followed with regard to an increase of size. In the Department's work at the Morgan Horse Farm, Middlebury, Vt., the brood mares average 15.0½ hands in height and 1,050 pounds in weight. General Gates, the leading stallion, stands 14.2½^a hands and weighs 1,000 pounds in breeding condition; his 4-year-old son, Red Oak, out of a large mare of excellent Morgan breeding, stands 15.0½ hands and weighs 1,000 pounds.

At this time it would appear safest to advise the selection of horses of Morgan breeding which show the closest conformity to the type, and to rely on selection to increase the size. The Department has tried the experiment of crossing General Gates on mares of Kentucky breeding whose dams were strong in Morgan blood. Thus far the results have been highly satisfactory, but the experiment has not progressed far enough to enable us to advise breeders to make such crosses. As a rule, the average breeder can not afford to experiment with out-crosses.

Blood lines must mean type-producing lines.—The safest standard for a breeder to adopt is to confine his operations as far as possible to Morgan blood lines, rigidly eliminating every animal which is not of Morgan type, or which is unsound, or shows the slightest

^a Erroneously reported as 15 hands in Twenty-fourth Annual Report, Bureau of Animal Industry, U. S. Department of Agriculture.

tendency to pace. Blood lines can not yet be drawn hard and fast in Morgan breeding. We must select type first of all, and by so selecting we will with each succeeding mating intensify the type and improve the pedigree. If the Morgan horse is to be regenerated, horses must be bred, not pedigrees. To breed horses which are in themselves good requires a comprehensive knowledge of horses and much more than average ability as a breeder; almost anyone can breed horses of good pedigree if he has the money to buy his founda-

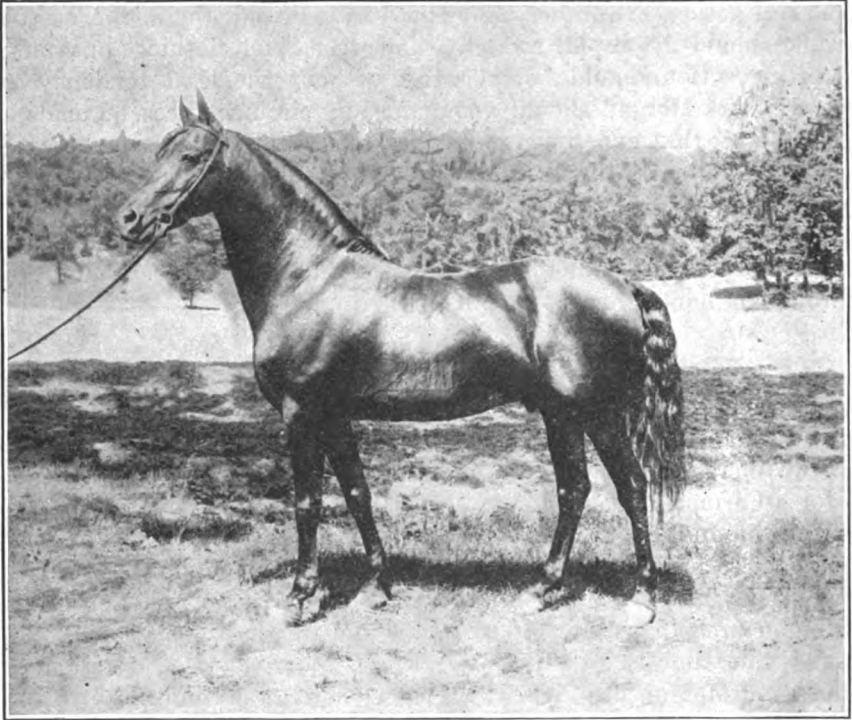


FIG. 2.— A modern Morgan. Stallion General Gates (666) at the head of the stud, United States Morgan Horse Farm, Middlebury, Vt.

tion animals. The test of the worth of a pedigree is the animal it produces. It follows, therefore, that a consideration of pedigree by a judge in the show ring is a *reductio ad absurdum*.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., June 17, 1910.

[Cir. 163]

636.073
U58
B95c

GENERAL LIBRARY,
UNIV. OF MICH.
NOV 10 1916

Issued November 5, 1910.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 164.

A. D. MELVIN, CHIEF OF BUREAU.

STATE LIVE-STOCK SANITARY OFFICERS.

ALABAMA.—State live-stock sanitary board: J. A. Wilkinson, chairman and commissioner of agriculture, Auburn; C. A. Cary, secretary and state veterinarian, Auburn; D. T. Gray, Auburn.

C. A. Cary, experiment station veterinarian, Auburn.

ARIZONA.—Live-stock sanitary board: George Pusch, chairman, Tucson; J. D. Carter, secretary, Phoenix; O. H. Christy, Phoenix; J. W. Stewart, Simmons.

Dr. J. C. Norton, territorial veterinarian, Phoenix.

ARKANSAS.—W. Lenton, state veterinarian, Fayetteville.

J. F. Stanford, experiment station veterinarian, Fayetteville.

CALIFORNIA.—Charles Keane, state veterinarian, Sacramento; W. E. S. Morrison, assistant state veterinarian, Los Angeles.

COLORADO.—State board of stock inspection commissioners: A. K. Stevens, president, Iola; E. McCrillis, secretary, Denver; H. W. Potter, treasurer, La Junta; Charles G. Lamb, state veterinarian, Denver.

George H. Glover, experiment station veterinarian, Fort Collins.

CONNECTICUT.—Heman O. Averill, commissioner on domestic animals, Hartford.

DELAWARE.—Abram E. Frantz, secretary state board of health, Wilmington. Board of veterinary examiners: James R. Mahafrey, Wilmington, and H. P. Eves, Wilmington.

Weasley Webb, corresponding secretary state board of agriculture, Wilmington.

Charles F. Dawson, experiment station veterinarian, Newark.

FLORIDA.—Joseph Y. Porter, state health officer, Jacksonville; Thomas J. Mahaffy, veterinarian to state board of health, Jacksonville.

GEORGIA.—Thomas G. Hudson, commissioner of agriculture, Atlanta.

Dr. D. P. F. Bahnsen, state veterinarian, Atlanta.

HAWAII.—V. A. Nørgaard, territorial veterinarian, Honolulu.

IDAHO.—George E. Noble, state veterinarian, Boise.

ILLINOIS.—State board of live-stock commissioners: Phil. S. Haner, chairman, Taylorville; Henry J. Beer, Blue Island; A. W. Sale, Springfield; J. M. Wright, state veterinarian, 1827 Wabash avenue, Chicago.

Donald McIntosh, experiment station veterinarian, Urbana.

A. T. Peters, assistant to experiment station veterinarian, Urbana.

INDIANA.—W. E. Coover, state veterinarian, Indianapolis; G. H. Roberts, assistant state veterinarian, Indianapolis.

R. A. Craig, experiment station veterinarian, Lafayette.

Veterinary medical examiners: George C. Ferling, Richmond; Orville L. Boor, Muncie; John J. Herron, Tipton; A. H. McGlasson, Madison.

IOWA.—Paul O. Koto, state veterinarian, Des Moines.

C. H. Stange, experiment station veterinarian, Ames.

KANSAS.—J. H. Mercer, live-stock sanitary commissioner, Topeka; F. S. Schoenleber, experiment station veterinarian, Manhattan.

KENTUCKY.—J. N. McCormack, secretary state board of health, Bowling Green; F. T. Eisenman, state veterinarian, Louisville; Hon. M. C. Rankin, chairman live-stock sanitary board, Frankfort.

LOUISIANA.—State live-stock sanitary board: Charles Schuler, chairman, Baton Rouge; E. P. Flower, secretary and executive officer, Baton Rouge; W. H. Dalrymple, J. H. Thurmond, and George W. Sentell.

W. H. Dalrymple, experiment station veterinarian, Baton Rouge.

MAINE.—State cattle commissioners: F. O. Beal, president, Bangor; John M. Deering, secretary, Saco; Frank S. Adams, Bowdoin.

State board of veterinary examiners: W. S. Lord, president, Portland; A. Joly, secretary and treasurer, Waterville; F. E. Freeman, Rockland.

MARYLAND.—Wade H. D. Warfield, secretary live-stock sanitary board, Cockeysville; F. H. Mackie, chief veterinary inspector, 1035 Cathedral street, Baltimore.

S. S. Buckley, experiment station veterinarian, College Park.

MASSACHUSETTS.—Frederick F. Walker, chief of cattle bureau, state board of agriculture, State House, Boston.

J. B. Paige, experiment station veterinarian, Amherst.

MICHIGAN.—State live-stock sanitary commission: H. H. Hinds, president, Stanton; C. A. Tyler, secretary, Coldwater; T. F. Marston, Bay City; W. M. Morris, state veterinarian, Cass City.

Charles E. Marshall, experiment station veterinarian, East Lansing.

MINNESOTA.—State live-stock sanitary board: C. E. Cotton, Minneapolis; Charles A. Nelson, Anoka; M. H. Reynolds, University Farm, St. Paul; P. H. Grogan, C. Sholin; S. H. Ward, veterinarian, secretary and executive officer, St. Paul.

M. H. Reynolds, experiment station veterinarian, University Farm, St. Paul.

MISSISSIPPI.—State live-stock sanitary board: H. E. Blakeslee, chairman and commissioner of agriculture and commerce, Jackson; W. L. Hutchinson, secretary, Agricultural College; James Lewis, state veterinarian, Agricultural College; J. M. Aldrich, Michigan City; John W. Day, Crystal Springs.

MISSOURI.—T. C. Wilson, secretary state board of agriculture, Columbia; D. F. Luckey, state veterinarian, Columbia.

J. W. Connaway, experiment station veterinarian, Columbia.

MONTANA.—State live-stock sanitary board: William Treacy, chairman; M. E. Knowles, secretary and state veterinarian; T. C. Power; all at Helena.

NEBRASKA.—Governor A. E. Shallenberger, ex officio state veterinarian, Lincoln; Paul Juckniess, deputy state veterinarian, Lincoln.

NEVADA.—T. F. Richardson, state veterinarian, Goldfield.

NEW HAMPSHIRE.—N. J. Bachelder, secretary state board of cattle commissioners, Concord.

NEW JERSEY.—State board of agriculture: E. B. Voorhees, president, New Brunswick; Franklin Dye, secretary, Trenton.

Commission on tuberculosis in animals: E. B. Voorhees, president, New Brunswick; Joseph B. Ward, vice-president, Lyons Farms; Franklin Dye, secretary, Trenton; C. H. Cook, treasurer, Trenton; A. A. Cortelyou, Neshanic; William C. Parry, Hainesport; B. E. Tine, Stanton.

Dr. Bruce S. Keator, secretary state board of health, Trenton.

[Cir. 164]

NEW MEXICO.—Cattle sanitary board (having charge also of horses and mules): Charles L. Ballard, president, Roswell; W. J. Linwood, secretary, Albuquerque; W. C. McDonald, Carrizozo; W. H. Jack, Silver City; W. J. Linwood, Raton; B. F. Pankey, Lamy; W. W. Cox, Organ.

Sheep sanitary board (having charge also of goats): Harry F. Lee, secretary, Albuquerque; Solomon Lunas, Los Lunas; H. W. Kelly, Las Vegas; Charles Sleter, Clayton; A. D. Garrett, Roswell; J. W. Akers, Santa Fe.

NEW YORK.—R. A. Pearson, commissioner of agriculture, Albany; J. F. De Vine, chief veterinarian, Albany.

NORTH CAROLINA.—W. A. Graham, commissioner of agriculture, Raleigh; W. G. Chrisman, state veterinarian, Raleigh; E. P. Wood, assistant veterinarian, Raleigh.

G. A. Roberts, experiment station veterinarian, West Raleigh.

NORTH DAKOTA.—State live-stock sanitary board: E. J. Walsh, president, Willow City; Andrew Veitch, Grand Forks; W. L. Richards, secretary, Dickinson; W. F. Crewe, veterinarian and executive officer, Devils Lake; J. W. Robinson, Garrison.

L. Van Es, experiment station veterinarian, Agricultural College.

OHIO.—Paul Fischer, state veterinarian, Columbus.

A. P. Sandles, secretary state live-stock commission, Columbus.

OKLAHOMA.—G. T. Bryan, superintendent live-stock inspection, Guthrie; Drs. J. K. Callicotte and W. B. McAlester, veterinarians to state board of agriculture, Guthrie.

A. J. Emery, chief dairy inspector, Guthrie.

L. L. Lewis, experiment station veterinarian.

OREGON.—W. H. Lytle, state veterinarian, Pendleton.

PENNSYLVANIA.—State live-stock sanitary board: Governor Edwin S. Stuart, president; S. H. Gilliland, state veterinarian; T. E. Munce, deputy state veterinarian; all at Harrisburg.

PORTO RICO.—Thomas A. Allen, veterinary inspector, health office, San Juan.

RHODE ISLAND.—State board of agriculture: John J. Dunn, secretary, Providence; John S. Pollard, veterinarian, Providence.

SOUTH CAROLINA.—M. Ray Powers, state veterinarian, Clemson College; R. O. Feeley, assistant veterinarian, Clemson College.

SOUTH DAKOTA.—State live-stock sanitary board: Thomas H. Hicks, chairman and state veterinarian, Milbank; Frank M. Stewart, president, Buffalo Gap; Frank R. Cock, secretary, Belle Fourche; J. N. Long, Waubay; P. H. O'Neil, Faulkton; W. W. Davis, Mount Vernon.

E. L. Moore, experiment station veterinarian, Brookings.

TENNESSEE.—John Thompson, commissioner of agriculture, Nashville.

J. H. McDowell, state live-stock commissioner, Nashville.

Moses Jacob, experiment station veterinarian, Knoxville.

TEXAS.—State live-stock sanitary commission: R. H. Harris, chairman, San Angelo; A. S. Gage, secretary, San Antonio; A. F. McClure, Stamford.

E. R. Forbes, state veterinarian, Fort Worth.

M. Francis, experiment station veterinarian, College Station.

UTAH.—A. Carrington Young, state veterinarian, 517 Judge Building, Salt Lake City.

State board of sheep commissioners: L. R. Anderson, president, Salt Lake City; Arthur A. Callister, secretary, Salt Lake City; Thomas W. Jones, Salt Lake City; J. S. Ostler, Nephi.

H. J. Frederick, experiment station veterinarian, Logan.

VERMONT.—F. L. Davis, state cattle commissioner, White River Junction.

[Cir. 164]

VIRGINIA.—J. G. Ferneyhough, state veterinarian, Burkeville.

William D. Saunders, dairy and food commissioner, Richmond.

State board of veterinary examiners: H. S. Willis, Rapidan; Thomas Fraser, Richmond; S. C. Neff, Staunton; H. Bannister, Roanoke.

WASHINGTON.—S. B. Nelson, state veterinarian, Spokane.

WEST VIRGINIA.—John M. Millan, secretary state board of agriculture, Charleston.

Consulting veterinarians: W. C. Atkeson, Buffalo; J. C. Callender, Parkersburg; L. N. Reefer, Wheeling; W. M. Stanley, Charleston.

WISCONSIN.—State live-stock sanitary board: Herbert Lothe, secretary, Madison; D. B. Clark, state veterinarian, Madison; M. P. Ravenel, bacteriologist, Madison; George McKerrow, Pewaukee; George Wylie, Morrisonville; Grant U. Fisher, Janesville.

H. L. Russell, dean, college of agriculture, University of Wisconsin, Madison.

A. S. Alexander, experiment station veterinarian, Madison.

WYOMING.—William F. Pflaeging, state veterinarian, Cheyenne.

State board of live-stock commissioners: George R. Eyken, Laramie; Fred G. S. Heese, Buffalo; Addison A. Spaugh, Manville; Thomas Durbin, secretary, Cheyenne.

State board of sheep commissioners: William Daley, president, Rawlins; C. E. Verry, secretary-treasurer, Cheyenne; W. D. McKeon, Newcastle; J. M. Wilson, Douglas.

C. L. Prien, experiment station veterinarian, Laramie.

UNITED STATES LIVE-STOCK SANITARY ASSOCIATION: President, C. E. Cotton, 615 Fourth avenue south, Minneapolis, Minn.; vice-presidents, John R. Mohler, Washington, D. C.; P. S. Haner, Taylorville, Ill.; Paul Juckniess, Lincoln, Nebr.; C. A. Cary, Auburn, Ala.; S. B. Nelson, Spokane, Wash.; secretary and treasurer, J. J. Ferguson, Union Stock Yards, Chicago, Ill.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *September 21, 1910.*

[Cir. 164]



636.073
U5-8
B95C

Issued December 29, 1910.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 165.

A. D. MELVIN, CHIEF OF BUREAU.

JAN 19

METHODS FOR THE ERADICATION OF GID.

BY

MAURICE C. HALL,
Junior Zoologist, Zoological Division.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY,
and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

CONTENTS.

	Page.
Presence of gid in the United States	5
Losses from gid	5
Desirability of eradication	6
Life history of the gid parasite	6
Life history in relation to Montana conditions	8
Symptoms of gid	11
Comparison with symptoms of loco poisoning	11
Comparison with symptoms of grub in the head	12
The eradication of gid	13
Necessity for destroying heads and brains	13
Methods for destroying heads and brains	17
Disposal of giddy sheep	18
Operation as a substitute for slaughter	20
Administration of tapeworm medicine to dogs	25
Favorable time for eradication measures	28
Summary	29

ILLUSTRATIONS.

PLATE.	Page.
PLATE I. Gid parasite from brain of sheep	6

TEXT FIGURES.	
FIG. 1. Map of Montana, showing distribution of gid in sheep	4
2. Brain of giddy sheep, showing gid parasite	7
3. Adult gid tapeworm from the dog	8
4. Gravid segment of gid tapeworm	9
5. Egg of gid tapeworm	9
6. Brain of sheep in early stages of gid	10
7. Larval tapeworm head dissected away from the wall of a gid bladder-worm	11
8. White loco weed (<i>Aragallus lamberti</i>) in flower	12
9. Giddy sheep on infected range in Cascade County, Mont.	13
10. A giddy sheep	14
11. Simultaneous infection of sheep with gid and grub in the head	15
12. Glass hypodermic syringe	21
13. Instruments used in trephine operation	22
14. Instruments used in trocar operation	24

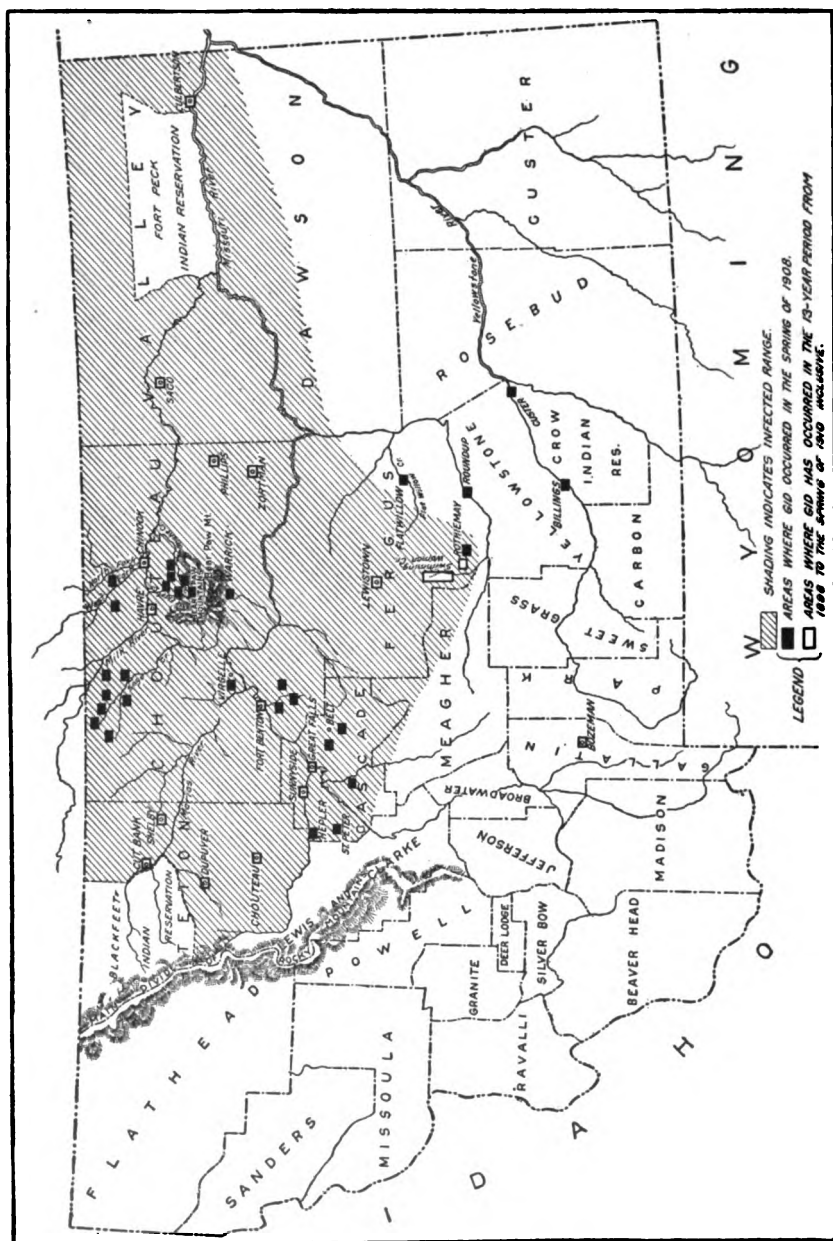


FIG. 1.—Map of Montana, showing distribution of gid in sheep.

METHODS FOR THE ERADICATION OF GID.

PRESENCE OF GID IN THE UNITED STATES.

For over a century claims have been published to the effect that the sheep disease known as gid existed in the United States. Abundant evidence indicates that it certainly has had a foothold in this country for over twenty years. During this period it has been reported, apparently correctly, from New York, Ohio, Illinois, Iowa, Michigan, Missouri, Kansas, Indian Territory, Montana, and Nevada. In many of these cases the diseased animals appear to have been imported, in some cases from Europe; but in at least three of these States—New York, Iowa, and Montana—the disease has been acquired from infected range or pasture. The cases in New York occurred in 1909 and those in Iowa in 1910. In Montana the range has been infected for at least twenty years, and during that period the infected area has increased until a territory 400 miles long and in places 200 miles wide is infected range. This area is in northern Montana and includes Teton, Chouteau, Valley, and Cascade counties and the northern part of Meagher, Fergus, and Dawson counties. (See map, fig. 1.) From outside of this area come numerous reports of cases of gid in Montana, but such cases usually have a history indicating that they were brought from the infected northern area. Such movements of sheep constitute the means whereby the total infected area may be increased in the future as it has been increased in the past to its present extent.

LOSSES FROM GID.

The evidence obtained by the writer in an investigation of gid in Montana in the spring of 1910 indicates that the total loss from gid is at least \$10,000 in some years. The extent of the loss is not appreciated by most sheepmen, as the disease is not known by name or is mistaken for other things even by sheepmen who have lost sheep from it for twenty years. The great majority of them confuse it with loco disease and call it by this name. In one place where there was no loco and it was evident that the disease could not be loco disease, gid was known as "lamb loco" from the well-known fact that lambs and yearlings are most susceptible to it. Another reason why the extent of the loss from this source is not appreciated is that

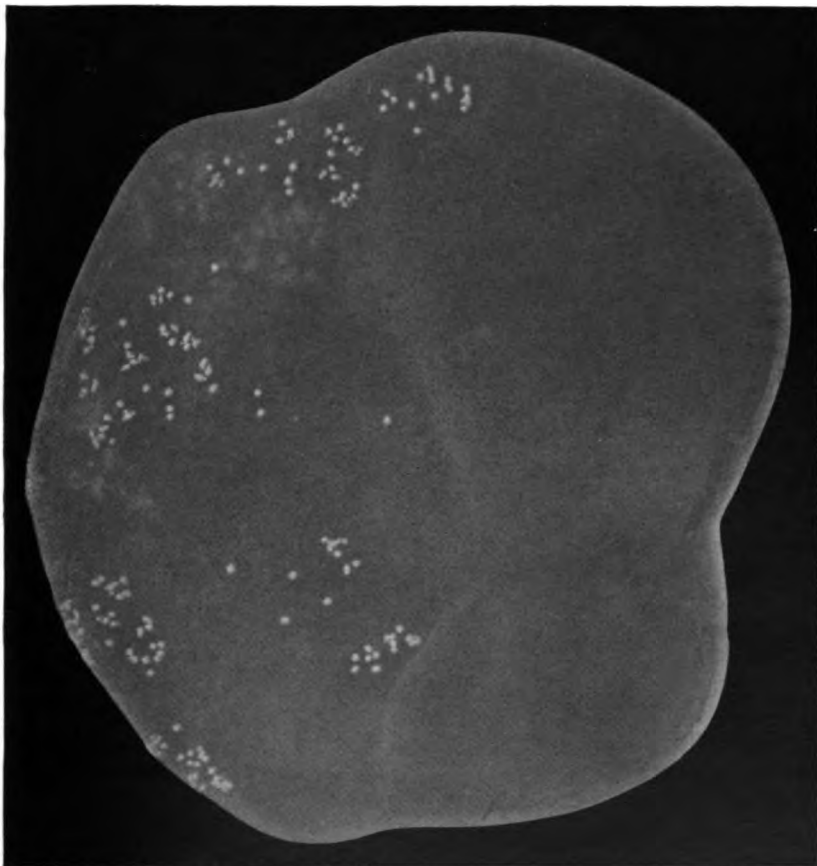
giddy sheep tend to stray from the flock and fall a prey to coyotes, and in some outfits giddy sheep are left behind when they become difficult to herd and these are also eaten by coyotes. The losses reported vary from 2 or 3 to 400, being at times 10 per cent of the entire flock. Some sheepmen lose more sheep from gid than from any other cause.

DESIRABILITY OF ERADICATION.

Such losses alone would justify vigorous efforts to eradicate the disease. The history of the disease in Europe adds additional reason for prompt eradication of the disease from the United States. The present comparatively small loss of \$10,000 a year from gid in this country is not the only thing to be considered. The fact that gid has gained a foothold in the United States means that the disease, unless controlled, will become more widespread in the future and will probably cause losses of many times \$10,000 a year. Furthermore, the more widely disseminated the disease becomes, the more difficult and costly it will be to eradicate it. For over half a century European flocks have suffered a steady and considerable loss from this disease in spite of the fact that during that time there has been adequate knowledge of measures for its suppression. It remains to be seen whether the sheepmen of Montana can eradicate a disease which the farmers and peasantry of Europe have been unable to eradicate. The Bureau of Animal Industry is confident that such a thing can be accomplished in the case of gid, as it has been accomplished in the case of foot-and-mouth disease and of contagious pleuro-pneumonia of cattle. Both of these diseases have obtained a foothold in the United States and have been eradicated in spite of the fact that European countries have been unable to accomplish such results. Compared with the elimination of these diseases or the struggle against Texas fever, the eradication of gid is a very simple matter. The symptoms are very striking and readily recognized by any sheepman, and the method by which the disease may be prevented is child's play compared with the treatment involved in handling such disease as lip-and-leg ulceration.

LIFE HISTORY OF THE GID PARASITE.

Gid is a disease due to the presence in the brain, or, rarely, in the spinal cord of the sheep of a larval tapeworm parasite having the general appearance of a fish bladder full of water (see Pl. I and figs. 2 and 11). This parasite is commonly known by the scientific name *Cœnurus cerebralis*, but the correct name is *Multiceps multiceps*. It is translucent and at times larger than a hen's egg. On this bladder are a number of white objects about the size of a grain of wheat and projecting, usually, into the fluid with which the bag is filled. These



GID PARASITE FROM BRAIN OF SHEEP.

The heads on the upper and lower surfaces and in some cases the openings of the necks to the exterior of the parasite are shown. (Slightly reduced.)

objects are tapeworm heads. On feeding this bladderworm, as the gid parasite is called, to a dog, the bladder digests, but the tapeworm heads pass on to the intestine, where they add segment after segment back of the head, till in the course of a month or two each head has become the head of one of the familiar segmented tapeworms, the worms in this case becoming 2 or 3 feet long (see fig. 3). Having attained this size, the posterior segments (see fig. 4), which contain hundreds of very small tapeworm eggs, begin to break off and are passed out onto the range or pasture with the feces. Under favorable conditions these eggs (fig. 5) are washed onto the grass or into standing or running water, and sheep eating grass or drinking water so infected thereby take the eggs into the stomach. Here the shell digests off and a very small embryo, armed with six hooks, bores its way through the walls of the digestive tract by means of these hooks, gets into the blood vessels, and is swept around till it lodges. In any location except the brain or spinal cord the parasite may grow to the size of a pea, but at that point or sooner it degenerates and dies. Those that get to the brain or spinal cord develop into the bladderworm described above.

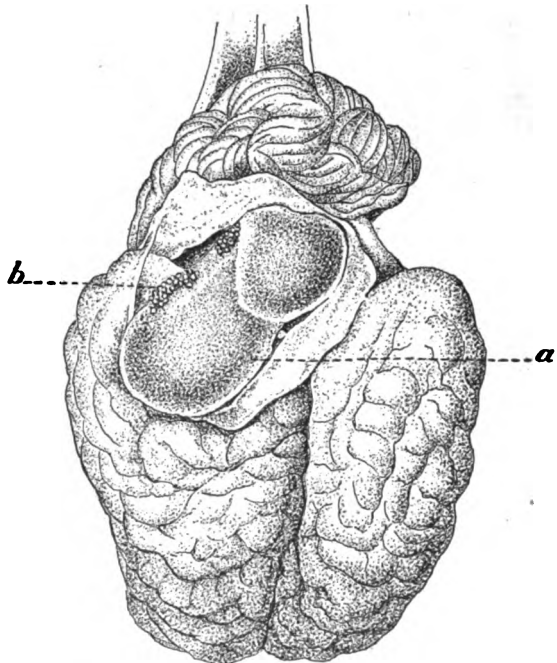


FIG. 2.—Brain of giddy sheep, showing gid parasite. *a*, Gid parasite or bladderworm; *b*, heads on bladderworm. (After Numan, 1850, Pl. I, fig. 1.)

At the time when the embryos get to the brain and begin to travel on its surface or through its substance there are usually slight symptoms of fever and restlessness, which are easily overlooked. Should the infection be severe enough to kill the sheep at this stage, an examination of the brain will disclose a number of curving channels on its surface. (See fig. 6.) But as a rule these symptoms abate and there is no further indication of the presence of the parasite until it has grown to the point where the heads form on the bladder and set up the symptoms characteristic of the last stages of gid by projecting out of the bladder and into the brain. This is accomplished by

virtue of the fact that the head is seated at the bottom of a little tubular neck with an opening to the exterior. Ordinarily this neck projects into the bladder fluid; but the head and neck can be projected through the opening mentioned, the neck turning inside out, just as a glove finger might be turned inside out. (See fig. 7.) When the head is pushed out it brings the crown of hooks with which it is armed into contact with the brain, and it is to the irritating action of these hooks on the brain that such symptoms as walking in a circle

are ascribed. It seems probable that only such symptoms as circling or running or jumping without apparent cause, which are of an intermittent and occasional sort, should be referred to the action of the tapeworm heads. Such symptoms as are constant in the last stages of the disease, including blindness, constant carriage of the head to one side, loss of appetite, and the like, should probably be referred to atrophy of the brain due to the pressure of the parasite, and to other nervous disturbances resulting from this pressure.

The final symptoms of gid do not show until seven or eight months after the sheep has become infected, the sheep usually dying about nine months after the time of infection. This point is important, because the Montana sheepmen, being unacquainted with the true nature of the disease, have been inclined to attribute gid to the nature of the country in which the sheep were feeding at the time of the outbreak,

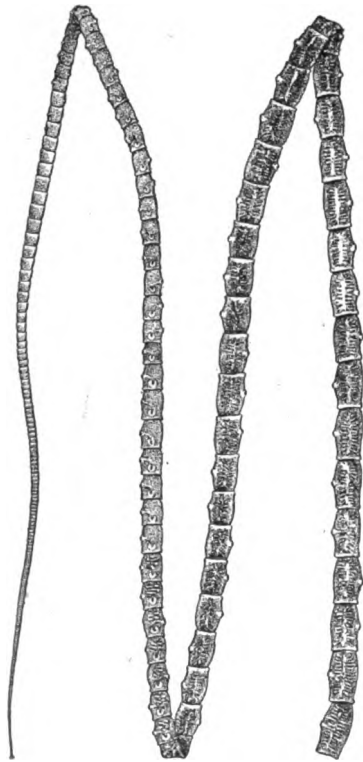


FIG. 3.—Adult gid tapeworm from the dog. Natural size. (Specimen No. 4031, Bureau of Animal Industry helminthological collection.)

and it is difficult to convince them that the infection was more or less remote from the range where the outbreak occurs.

LIFE HISTORY IN RELATION TO MONTANA CONDITIONS.

The actual history of the disease in most cases in Montana seems to be about as follows: The developed larval parasite, capable of infecting the dog, is found in sheep mostly while on the winter range from December to the end of March, exceptional cases occurring outside of this period. The adult worms develop in dogs, and probably

in coyotes and other wolves also, from eating the heads of sheep dying of gid during the months mentioned. These worms require a month or two to develop to the point where the tapeworm eggs are passed with the feces, and eggs from dogs infected at this time are probably being spread over the pasture and range any time after the 1st of February. Up to the time of the spring rains it is unlikely that many sheep become infected. It is the common testimony of writers on this subject that sheep avoid eating grass covered with fecal deposits, and it is likely that up to the time of the rains the eggs would generally lie alive and untouched or else perish. A number of writers have stated that dog feces act as a fertilizer and cause a fine growth of grass, thus attracting sheep to the spot where defecation occurred and leading to the infection of the sheep. This theory is probably far from the fact. When sheep and dogs in their usual numerical ratio are on the same pasture or range, the crop of grass over the entire area would owe much less to the dog feces than to the sheep feces, and the growth for equal amounts of feces of both sorts would be less for those of the dog.

Finally, the tapeworm eggs would have perished long before the dog feces had weathered and decomposed to the point where they became good fertilizer and the grass had responded to this by a noticeably improved growth. It is only as the feces are promptly broken up by water and the eggs released that sheep are liable to become infected. From the time the spring rains set in—usually during May, it is said—the sheep, now on summer range, take up the infection. The beating rain breaks up the dog feces, washes the tapeworm eggs into puddles and reservoirs from which the sheep drink, and splashes them on the grass which the sheep eat. Allowing the usual nine months' period of development, sheep infected in May will die in December. The deaths from January to March, inclusive, indicate that the storms of June, July, and August play a part in the infection of sheep. From this time dry weather apparently saves the sheep from further infection on the summer range, and on removal to

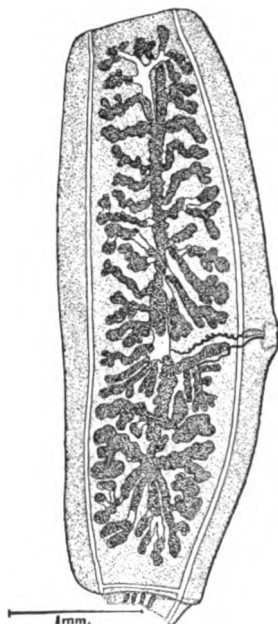


FIG. 4.—Gravid segment of gid tapeworm, showing the branching uterus full of eggs. (Specimen No. 4031, Bureau of Animal Industry helminthological collection.)



FIG. 5.—Egg of gid tapeworm.

winter range cold weather probably serves to keep the feces frozen, and thereby prevents them from breaking up and washing about. The death at this time of sheep infected the previous spring and summer gives opportunity for renewed infection of dogs and probably of other carnivora. Thus the life cycle takes about a year for its completion, and is closely related to weather conditions.

It appears from a study of field conditions that gid is most prevalent in the winters following a spring when the rainfall is abundant, an opinion expressed by many European writers, and in places where the range is most thoroughly carpeted with forage. In parts of the plains country of southeastern Montana where the forage is largely

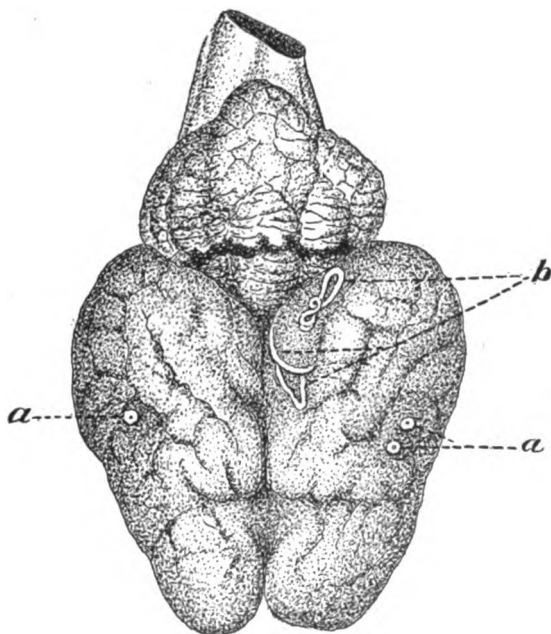


FIG. 6.—Brain of sheep in early stages of gid. *a*, Small developing parasites; *b*, channels due to wandering of parasites on surface of brain.

bunch grass, the range has not yet become infected, in spite of giddy sheep brought in from the infected region. The infection seems to persist better in upland valleys such as the country bordering the Judith Basin, and around the mountains such as the Sweet Grass Hills and the Little Belt Mountains. In some of these infected localities the ground is covered with a moss in the spring, and it is said that the sheep are very fond of this. It seems evident that the washing about of feces deposited on such a moss carpet or on a range where the grass grows in a continuous mat would be more certain to leave tapeworm eggs where sheep would get them than feces deposited on the bare ground in a country where they could wash along on the ground between scattered bunches of grass. The necessity of watering sheep on summer range at shallow watering places and in reservoirs and ponds in coulees where contamination by dogs is inevitable must also play some part in the infection of sheep.

The writer learned of two instances in Montana where outbreaks of gid were believed to be due to feeding hay which had been contaminated by dogs which were allowed to sleep on it.

SYMPTOMS OF GID.**COMPARISON WITH SYMPTOMS OF LOCO POISONING.**

In a general way the symptoms of gid in sheep are such that the sheepmen may be pardoned for confusing gid with loco disease, due to eating white loco weed (fig. 8). Close observation, however, will readily distinguish one from the other. Locoed sheep show symptoms of poisoning, while giddy sheep show evidences of brain trouble or more rarely of trouble in the spinal cord. Locoed sheep are nervous, uncertain in their movements, and out of condition, but they never show the regular automatic repetition of some unusual movement that giddy sheep show. Giddy sheep very commonly turn in a circle, a very characteristic symptom. The circle may be relatively large or very small, or the sheep may even pivot in one place. A giddy sheep will sometimes graze for awhile, then raise its head as if it had just thought of something and start off for it, swinging around in a circle and perhaps stopping and beginning to feed in the place from which it started. Later, the sheep will circle for hours without stopping. Less often the sheep will throw the head back and bolt in a straight line as if frightened, or perhaps put the head between the front legs and go stumbling forward. The head is often held to one side and may be raised or lowered. (See figs. 9 and 10.)



FIG. 7.—Larval tapeworm head dissected away from the wall of a gid bladderworm. (Specimen No. 3644, Bureau of Animal Industry helminthological collection.) (From Bureau of Animal Industry Bulletin 66.)

On the range the first symptom that the herder notices is that giddy sheep become hard to herd. They lag behind the flock, and when the dog is sent to bring them up, instead of running into the flock as normal sheep would, they run away from it. When the rest of the flock is standing quiet, giddy sheep can be seen worming restlessly about in it; and while the others are feeding, giddy sheep will be executing some meaningless maneuver, such as circling or running without any apparent cause.

Locoed sheep when put on alfalfa will nearly always recover; giddy sheep will show no abatement of symptoms and will invariably die unless operated on. When a sheepman has any doubt as to whether his sheep have gid or some disease which merely resembles gid, it will pay to kill a sheep and examine the brain. The developed gid para-

site is large and easily recognizable as a bag full of fluid, and its presence is proof that the sheep had gid. It is of course perfectly possible for a sheep to have loco disease and gid simultaneously, though no cases of this sort are known, so far as available records show.

COMPARISON WITH SYMPTOMS OF GRUB IN THE HEAD.

Sheep which are infected with so-called "grub in the head" (the larva of *Æstrus ovis*, the sheep gadfly) may sometimes be suspected of having gid. However, such sheep are characterized by a catarrh or "snotty nose," due to the irritation caused by the parasite in the nose and frontal sinuses. They do not show the automatic movements of giddy sheep. Grub in the head is rarely fatal, though sheep may die from a massive infection or from the larva or grub penetrating to the brain, a thing which it is claimed may happen in rare cases. The disease may be definitely diagnosed by a post-mortem examination of the back part of the nose and frontal sinuses, where grubs, similar to those shown in figure 11, will be found if the

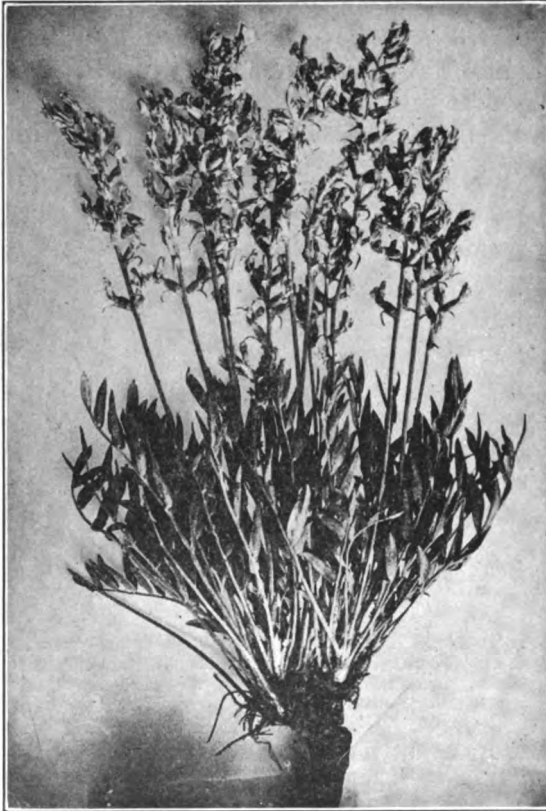


FIG. 8.—White loco weed (*Aragallus lamberti*) in flower.
(From Farmers' Bulletin 380.)

disease is "grub in the head." This disease is especially common in Sweet Grass County. Gid and grub in the head sometimes occur in the same sheep, as figure 11 indicates, and a sheep which circles may be suspected of having gid even though the presence of the *Æstrus* larvæ is also indicated.

THE ERADICATION OF GID.

Knowing the life history of the gid parasite, the eradication of the disease becomes a very simple matter. It is only necessary to step in at some point where the parasite is most easily attacked and prevent its further development. This is accomplished in two ways: first, by destroying the heads, or at least the brains, of sheep dying of gid; and second, by keeping sheep dogs or other ranch dogs free of tapeworms. Of these two steps the first is much the more important, for the reason that it is much more practical and effective than the second and also is much easier.

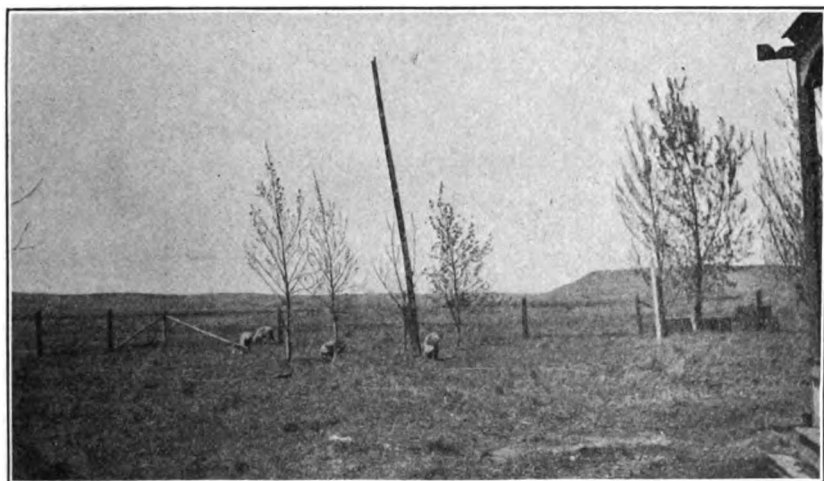


FIG 9.—Giddy sheep on infected range in Cascade County, Montana. The sheep in front of the tree has gid and shows the characteristic circling attitude.

NECESSITY FOR DESTROYING HEADS AND BRAINS.

Claims have been made to the effect that the destruction of the heads of giddy sheep is unnecessary, on the ground that dogs do not eat sheep heads. In a former publication ^a the writer has shown the unlikelihood of scientists being mistaken as regards the life history of the gid parasite, and has shown by experiments that a dog not only would eat a sheep head, but having once eaten one, would subsequently go for the brains first of all when given a sheep head. It was shown that a dog would at times eat a skull so completely as to leave almost nothing, and at times lick the brains out through the foramen magnum and leave the skull apparently intact; in neither case would there be anything to suggest to the casual observer that a dog had eaten the brains. The writer has recently repeated this

^aBureau of Animal Industry Circular 159.

experiment and confirmed the earlier findings. A hound weighing 32 pounds was fed an unskinned sheep head, the tongue alone being removed. Three hours later the hound had eaten the brains and the entire back part of the skull, leaving only the nose and the upper and lower jaws. The next morning only the lower jawbones and the back part of the upper jawbones were left. The dog was then fed a sheep head which had had the top chopped in and the brains broken up and covered with 130 cubic centimeters (a pint equals about 568 cubic centimeters) of 5 per cent solution of formaldehyde. Inside of four hours the dog had eaten the brains in spite of this formalde-

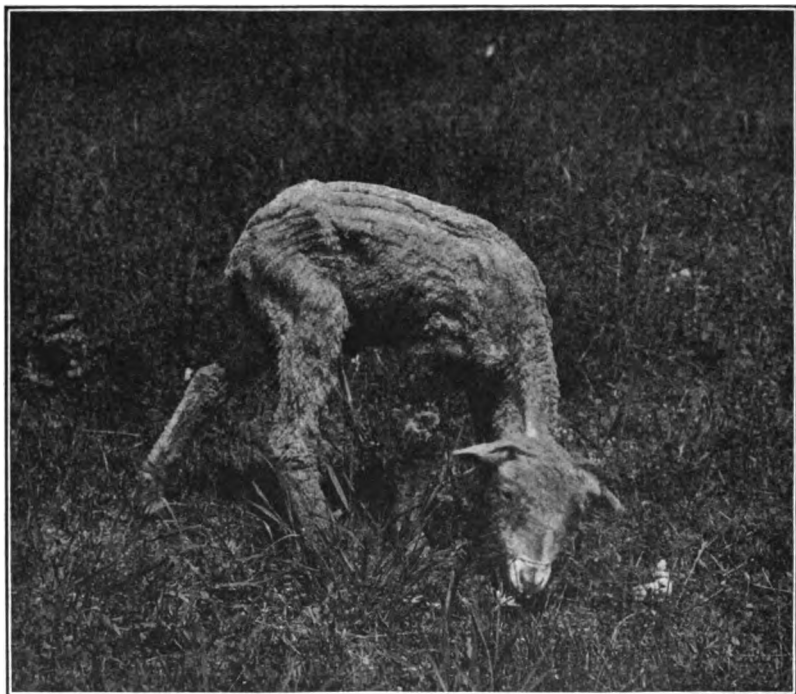


FIG. 10.—A giddy sheep, shipped from Gildford, Mont., to Washington, D. C. The position of the head and neck and the emaciation are characteristic.

hyde, although it caused the brains to be vomited a little later. The next day the top of a sheep head was chopped in, the brains mashed up and covered with 200 cubic centimeters of coal oil and the oil set on fire. It burned for almost half an hour. The head was then given to the dog. The next morning the hound had eaten the brain and cleaned up the bones of the burned head. The next day a sheep head was split and the brains scooped out and covered with 100 cubic centimeters of turpentine. Three hours later the hound had eaten a small piece of the brains in spite of the turpentine. By the next noon he had eaten a little more. He was then fed a fresh set of brains

covered with 50 cubic centimeters of 40 per cent formaldehyde solution. These were untouched the next noon. Brains covered with 50 cubic centimeters of coal-tar-creosote, lime-and-sulphur, or cresol sheep dips were successively left with the dog for thirty hours and were untouched at the end of that time in all cases.

A somewhat similar set of experiments was meanwhile being carried on with a mongrel dog weighing about 30 pounds. This dog was fed a sheep head at the same time that the hound was fed the first head, but two days later he had only gnawed at the meat and had failed to get at the brain. The next day he was fed a sheep head the brain case of which had been broken up and the brains and head covered with coal oil and burned as above described. By the following day the brains had been eaten and the bones cleaned. A second sheep head which had been split open and not treated with chemicals of any sort was left with this dog all this day but was ignored. Brains taken out and treated with 100 cubic centimeters of turpentine were left untouched for twenty-eight hours. Brains treated with 50 cubic centimeters of 40 per cent formaldehyde

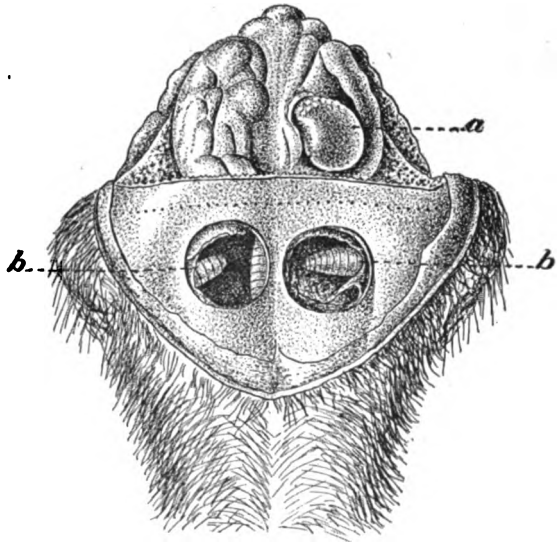


FIG. 11.—Simultaneous infection of sheep with gid and grub in the head. The gid parasite (a) is shown issuing from the brain. The grubs or *Oestrus* larvæ (b) are shown in the frontal sinuses, being exposed by openings made with a trephine. (After Moussu and Dollar, 1905, p. 468.)

solution were left untouched for eighteen hours, and then half of the brains was eaten, though it was of a rubbery consistency and must have been as indigestible as it was unpalatable. Brains covered with 50 cubic centimeters of coal-tar-creosote, lime-and-sulphur, or lime-and-tobacco sheep dips were untouched after being left with the dog thirty hours in each case.

The shepherd dog used in the experiment described in the writer's former article, already referred to, was fed an unskinned sheep head after an interval of over nine months since the first experiment. The first day some of the outer parts only were eaten in seven hours. After an interval of a day the head was fed again, and this time it was picked down to the bones, but the brain case was not entered. The remainder of the head was left overnight and the next morning

examination showed that the dog, following the method used on the former occasion, had licked out the brain through the foramen magnum, the opening where the spinal cord enters the brain. This opening had been enlarged little, if any, by the dog's teeth. A sheep head fed about a week later was treated the same way. The meat was eaten off the skull the first day and the brain licked out the evening of the second day.

Two coyote pups, between 5 and 6 months old and weighing, respectively, 12½ and 14½ pounds, were fed two unskinned and intact sheep heads. After forty-eight hours the coyotes had still been unable to get at the brains. The coyotes were too small and too young to permit of any conclusions in regard to the adult coyote being drawn from this fact. Indeed, it may safely be asserted that an adult coyote would have as little difficulty in getting at the brains as a dog would. A sheep brain covered with a lime-and-sulphur dip and one covered with a coal-tar dip were fed to the coyotes. Small parts of the brain covered with the lime and sulphur were eaten at once, in seven hours half of it was eaten, and in twenty-four hours it had all been eaten. The brain covered with coal-tar dip had been only partly eaten in the same time. After being fed one regular meal the coyotes were given one sheep brain covered with 40 per cent formaldehyde and one covered with turpentine. Eighteen hours later the coyotes had eaten both brains and had vomited them, owing to the formaldehyde and turpentine. A brain covered with 50 cubic centimeters of coal oil was eaten within half an hour and one which had been burned with the same amount of oil and some wool was eaten at once.

It is evident from the above experiments that some dogs, perhaps from being accustomed to cooked foods or to dainties, do not care much for sheep heads. The existence of such dogs is, however, of no consequence so long as dogs which do like sheep heads exist. It must be conceded that some dogs do like sheep heads and are especially fond of brains when they will eat them covered with formaldehyde or turpentine or burned in coal oil. The dogs used in the above experiments were fed the sheep heads and brains in place of their regular meals, and if the heads and brains were not eaten in thirty hours the dogs were put on their regular diet for a day or two. It is also evident that coyotes like sheep brains.

The evidence that dogs eat sheep brains, even where these are protected by the skull, is not entirely experimental. During the investigation in Montana, the writer asked a large number of sheepmen whether their dogs would eat sheep heads and the answer was never in the negative. Some did not know. Many claimed to have seen dogs eat sheep heads. One sheepman said he had seen a dog eat a sheep head and only leave a few splinters of bone uneaten. Another

stated that he had a dog which preferred sheep brains and would break open skulls to get them. Another stated that coyotes are fond of the brains of young sheep, and one man had seen what he took to be fragments of sheep skulls around coyote dens. Such testimony, fitting in, as it does, with the known facts and the experimental indications, must be held to more than offset the negative testimony of those who, in correspondence with the Bureau, claim that they know of no one who has seen dogs eating sheep skulls.

METHODS OF DESTROYING HEADS AND BRAINS.

One method of destroying heads of giddy sheep which the writer has advocated among Montana sheepmen is to burn the sheep head where this is practicable. One man whom the writer met in Montana claims to do this. Another burns them or throws them in an abandoned well. A plan which is quite as good or perhaps better is to split the head longitudinally with an ax or meat cleaver and get out the brain and burn it. This plan has the advantage that it does not require a quantity of wood, which is a scarce article over a large part of Montana's sheep ranges. The brain can be burned on a forkful of hay or straw and the parasite effectually destroyed. Coal oil in small amounts does not generate enough heat. Burning is practicable where wood or hay is available or where the sheep can be brought up to the home ranch and killed.

These conditions can not be met with in many cases, and the simple procedure advocated in such cases is to have the herder carry, as part of his wagon equipment (since most Montana herders work out from a wagon), an ax or a meat cleaver and a bottle or jug filled with any one of a number of fluids that would serve to kill the gid parasite and to discourage dogs or other carnivora from eating brains which had been covered with such substances. Among other things which a well-fed dog or a hungry and suspicious coyote would usually avoid are 40 per cent formaldehyde, turpentine, or the always available sheep dips of the coal-tar creosote, tobacco, and cresol varieties. Coal oil is too volatile, lacking in penetration, and not sufficiently repellent. The lime-and-sulphur dip might be used, but is not recommended, as it is not as strong or as repellent as the other things. The substances recommended have the advantage of being fatal to tapeworms on contact without being fatal to dogs, a point of interest to the man who must consider the possible danger to his sheep dogs. A dog might eat enough to make himself sick, but could hardly eat enough of such repellent substances to kill him, as vomiting would usually ensue and relieve the stomach. These substances need only be used in small quantities, and hence are easy to carry and inexpensive.

When a sheep becomes hard to herd, circles, or shows other definite signs of gid, it should be marked, a thing easily accomplished by tying a rag or something of the sort to the wool or about the neck, and when the band is brought up to the bedding ground for the night this sheep should be killed and the brain destroyed.

The best way to destroy the brain when it can not be burned is to split the skull longitudinally with an ax or cleaver, scoop out the two halves of the brain, chop them up or crush them, and pour on them turpentine, formaldehyde, or one of the sheep dips mentioned above. This operation takes only a minute or two, and the death of the gid parasite in the brain would follow in a few seconds after the application of the substances mentioned. A cleaver weighing 1½ pounds is heavy enough to split a sheep skull without difficulty. The brains should be completely covered with the turpentine or whatever is used, but even then it only requires a small amount to do the work. Fifty cubic centimeters (less than a tenth of a pint) would be sufficient if carefully applied, and while it would be undesirable to scant the amount, nevertheless a quart bottle would hold an ample supply for one herder for a season under ordinary conditions. Chopping in the top of the skull, and leaving the brains in place after breaking them up and covering with some repellent fluid, is not sufficiently thorough in actual practice. The fluid does not penetrate sufficiently and there is no saving of time.

In the experiment where the sheep heads or brains were burned with coal oil, an investigation of the part of the brain farthest from the burning oil showed that its temperature had been raised very little, probably not enough to have killed a specimen of the gid parasite at that point had one been present. This indicates that in those cases where the heads are to be boiled and fed to the dogs, the boiling should be prolonged and thorough, and the skull should be broken so as to give the hot water free access to the brain.

DISPOSAL OF GIDDY SHEEP.

When a giddy sheep has been killed and the brain disposed of by the method just given, the pelt may be taken and the meat disposed of as desired. The writer met only one man in Montana who used the meat of giddy sheep for food. The meat is fit for food at the beginning of the last stages of the disease, before neglect of food has starved the animal and brought on a condition of emaciation. At the same time the usual sentiment among sheepmen is that they are too much accustomed to the best mutton to eat sheep that were in any way diseased. The advice of European writers to market giddy sheep is not well taken, as a rule, in Montana. The disease occurs mostly in winter, at a time when the sheep are not in condition to market and when none are being marketed. But in case the meat is not to

be used for man it can be fed to the herder's dogs, or if the camp tender is around it can be fed to the dogs at the home ranch, or, as one outfit does, to the hogs.

In a general way, it is evident that the persistence and spread of gid in Montana is largely due to the sheepman's ignorance of the nature and means of prevention of the disease. But it is also due to a characteristic carelessness. For years sheepmen have carried on the sheep business in a large, liberal way that in some cases has degenerated into mere shiftlessness. It is one thing not to worry about the loss of two or three or a dozen sheep. It is another thing to let the loss stand and make no effort to find out what caused it, or, having found out what caused it, to take no steps to learn how to prevent a recurrence, or to apply such knowledge when learned. Such conduct is not businesslike, and is not creditable from any standpoint, and yet it is not uncommon to find Montana sheepmen doing these things. However, they are not common among the larger outfits. Big owners and camp tenders for big outfits commonly take account of these things and apply proper measures.

Over a large part of Montana when a sheep dies the carcass is allowed to lie where it falls, the pelt being usually, but not always, stripped off. At one point the writer has seen nearly a hundred carcasses lying along a well-traveled road. Such a condition aids in spreading a disease like gid. At other places dead sheep and cattle were lying in shallow watering places, and no one would take the trouble to drop a rope over them and drag them to a convenient coulee. Animal and bacterial parasites could find no conditions in nature more certain and satisfactory for their spread than those offered by the immersion of a carcass in a public watering place. A stream of clear mountain water at the home ranch of one big outfit was defiled by throwing into it the skeletons of sheep after the meat had been fed to the hogs. Big owners with excellent water supplies, amply able to afford concrete watering troughs, preferred to let their sheep drink the water after it had run into a hole in the ground and become converted into a stagnant puddle. Montana sheepmen must come to an appreciation of the fact that clean water is not only wholesome but profitable.

Many sheepmen maintain a hospital band at the home ranch, and the sick, weak, and crippled sheep from all the bands are brought in to this point and given a chance to recuperate. Some outfits kill those sheep which can not keep up, and take the pelt. Others, when a sheep can not keep up, let it drift and take a chance on picking it up again—a very small chance on an open prairie in coyote country.

It is in keeping with the careless practices mentioned above that some sheepmen refuse to bother with a disease like gid, which takes from the flocks from two or three to forty sheep yearly, on the ground

that it is too small a matter. Others claim that it is impossible to get sheep herders to do anything more than herd the sheep, which is often true. However, a realization that under some conditions the loss may amount to hundreds of sheep, together with the increasing value of sheep, will probably induce sheepmen to pay more attention to this disease, especially when it is realized that the avoidable neglect of a simple method of prevention endangers not only the flocks of the owner, but also those of his neighbors. As for the herders, it is usually true that the outfits with the hardest working owners and sheep foremen get the best service from their herders.

OPERATION AS A SUBSTITUTE FOR SLAUGHTER.

A number of Montana sheepmen, mostly Scotchmen, who have handled "sturdied" or giddy sheep in Scotland, prefer to operate for gid instead of killing the sheep and destroying the brain. Of the two operative methods usual elsewhere, the use of the trocar and of the trephine, the trocar method alone is used in Montana so far as the writer learned, although such simple methods as cutting out a piece of bone with a pocketknife and extracting the cyst, or puncturing the cyst with a pocketknife, are more or less common. The writer talked with one man who in addition to these methods had tried boring a hole in the skull with a knife blade and using a rubbersyringe to suck out the parasite, and had also tried injecting a half teaspoonful of tincture of iodine and potassium iodide. Some men claim to save 50 per cent of sheep operated on, and claims were made of even higher percentages of success. Others, including one man who claimed to have operated on 50 sheep, had saved none.

It is commonly believed that operating instruments can be obtained only in Scotland or elsewhere in Europe. This is not correct. Trephine outfits can be purchased of any one of a number of makers of surgical instruments in the United States, and can be ordered from almost any druggist. Trocar outfits with cannula and syringe, designed expressly for operating on giddy sheep, can be imported through certain American firms. Such outfits, boxed, will cost up to \$9. Nevertheless trocars, cannulas, and syringes similar to those in figure 14 can be made to order in this country at a cost of \$5 or less. One or two sheep saved will pay for this. When a giddy sheep can not be marketed and will be fed to the dogs in any case, the sheep which die as a result of an operation are no loss, and those which are saved are clear gain.

Only the more favorable cases should be operated on. These are cases where the diagnosis indicates that the parasite is situated on the upper surface of the cerebrum, or large anterior part of the brain, and therefore accessible from an opening in the top of the skull. It is hardly possible always to locate a parasite accurately from the symp-

toms. The abnormal movements of the sheep are believed to be due to the everted tapeworm heads which irritate such parts of the brain as they come in contact with and thereby set up corresponding reactions. Inasmuch as a large cyst will have numerous heads capable of irritating the brain at relatively widely separated points, it will set up correspondingly variable reactions. At the same time certain symptoms will correctly indicate the location of the parasite in the majority of cases. Moreover, if the parasite is located on the upper surface of the brain it not uncommonly causes the formation of a soft spot in the skull just over the cyst, and this can be found by pressing firmly on the skull with the thumb till a place is found where the skull yields a little. As a rule, when such a place is pressed in the sheep will start violently. It may be that this is due to the pressure on the skull being communicated by hydrostatic pressure through the cyst, and thus causing the sudden simultaneous eversion of all or many of the tapeworm heads.

There are some sheep which can not be saved by operation. Some of these have the parasite in an inaccessible location at the base of the brain. Others

have several parasites in the brain and their detection and successful removal may be impossible. Still others have the

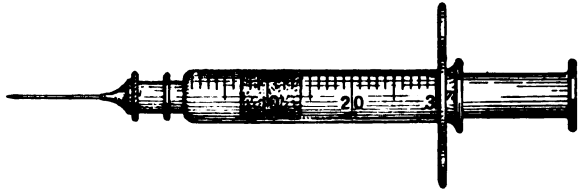


FIG. 12.—Glass hypodermic syringe.

parasite located in the cerebellum, the small posterior part of the brain, or in the spinal cord, and can not be successfully operated on. Finally, the operator will not always be successful and some sheep will die of meningitis or some other complication.

For the purpose of the sheepman who wishes to perform the operation for gid, only those animals that circle should be operated on. In a majority of these cases the parasite will be located in the cerebrum near the surface and on the side toward which the sheep turns. The soft spot in the skull, if present, will usually be found on this side. The sheep will usually have a peculiar stare and will often run into things as if blind.

In any operation avoid the middle line of the skull and operate to one side, as the main blood vessels are located in the middle line. It is advisable to use a local anesthetic, such as cocain, as it not only lessens the suffering of the animal, but also makes the animal easier to handle and operate on as a result of the lessened pain. For the purpose of injecting cocain, a hypodermic syringe, with a capacity of 2 cubic centimeters, can be purchased for a trifling sum. (See fig. 12.)

If a trephine outfit is used the trephine should have about a five-eighths inch cut (fig. 13, *a*). Besides the trephine there will be needed a knife or scalpel (see fig. 13, *b*)—an ordinary pocketknife will serve, but is not so easy to sterilize—a pair of fine scissors with the blades bent at an angle to the handle (fig. 13, *c*), a pair of forceps (fig. 13, *d*), an ordinary pair of shears (fig. 13, *e*), a curved surgical needle (fig. 13, *f*), and some thread. Sterilize the instruments by boiling at a place convenient to the operation. Operate in a place sheltered,

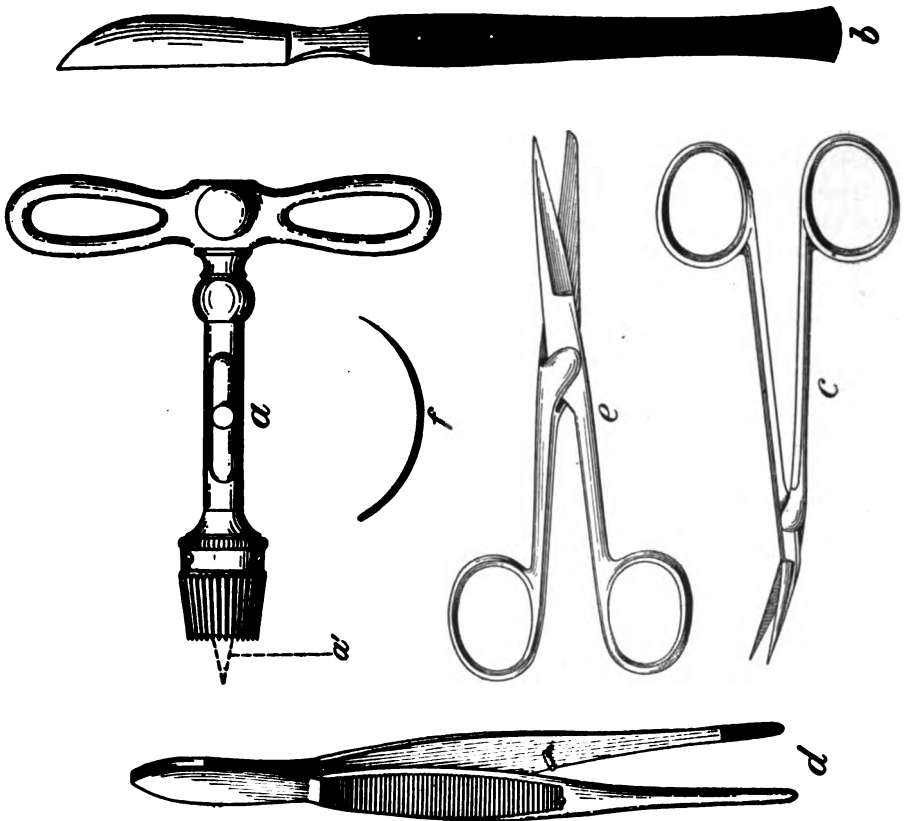


FIG. 13.—Instruments used in trephine operation. *a*, Trephine; *a'*, movable stylet of trephine; *b*, scalpel; *c*, fine scissors for cutting dura; *d*, forceps; *e*, scissors; *f*, surgical needle.

so far as possible, from wind and dust and sun, but with plenty of light to work by. The essential feature of the operation is cleanliness of the hands, of the instruments, and of the site of operation. It is useless to perform an operation of this sort in a careless fashion and with little regard for cleanliness, as the almost inevitable result will be a bacterial infection resulting in the death of the sheep and the loss of the time spent.

Inject 2 cubic centimeters of water with a one-eighth grain tablet of cocain dissolved in it at the site of operation, pushing the needle

through the skin and then moving it about so as to distribute the cocain all around the operation area. Shear the wool close over this area and for some distance around. Have the hands and the site of operation thoroughly cleaned with some antiseptic solution, such as 3 per cent carbolic acid solution (about a tablespoonful to the pint), or a solution of 1 to 1,000 potassium permanganate (put the amount of crystals that can be heaped on a quarter into a quart of water). Take the scalpel or knife and make a V-shaped incision with the place to be operated on included between the legs of the V. With the stylet of the trephine pushed out, start to cut, using the stylet to center the trephine. When the cut is started, draw back the stylet and cut till the bone breaks or is sawed through. In animals other than old rams with thick skulls it requires only a few turns of the wrist to accomplish this, and care must be taken not to press too hard. If the piece of bone comes out stuck in the trephine it can be removed with the stylet. If it does not come out, lift it out with the knife, breaking or cutting any unsawed adhesions. When bleeding occurs, sponge the bleeding parts with a piece of cotton batting or gauze moistened in the 3 per cent solution of carbolic acid or the 1 to 1,000 potassium permanganate solution. Make a cross-shaped cut in the hard membranous covering of the brain with the bent scissors, taking care to cut only the covering and not the brain.

If the parasite is located right at this point it will push out, often-times breaking, and may be grasped with a pair of forceps and drawn out. If it does not push out it may be sought for by inserting the forefinger, carefully washed in the antiseptic solution, into the opening and feeling around for a soft spot in the brain. If such a spot is found the finger may be drawn back and the parasite will usually follow it, and may be removed with the forceps. According to Pfab (1910),^a the cavity of the brain from which the parasite was removed should be washed out by means of a syringe until all bleeding stops, even though it takes half an hour for it to stop. A weak antiseptic solution, such as a carbolic acid solution of one-half of 1 per cent, a solution of 1 part of corrosive sublimate to 5,000 parts of water, or a 3 per cent borax solution, would probably be satisfactory for this. Tablets of corrosive sublimate sufficient for making solutions of known strength in given amounts of water can be purchased of druggists. Corrosive sublimate is poisonous and corrodes metal on contact and must be handled accordingly, using glass receptacles and glass or rubber syringes. Boiled normal salt solution (1 teaspoonful of salt to a quart of water) may be used to syringe out the cavity. Inject the solution gently with a large sterilized syringe, then withdraw it, empty the syringe, and repeat with fresh solution.

^a *Münchener Tierärztliche Wochenschrift*, Jahrgang 54, No. 7, pp. 109-114. München, February 15, 1910.

When the bleeding stops put the V-shaped flap of skin back in place and take a stitch through the tip of the V and a few along the upper side. Leave the other side free, and do not put back the piece of bone. This will give the wound a chance to drain and prevent the animal from dying of a pus accumulation on the brain. Cover the wound with a pad of cotton wrapped in gauze, or of gauze alone, the pad being moistened with 3 per cent carbolic or 1 to 1,000 potassium permanganate solution, and tie this in place with a strip of cloth. Keep the animal quiet and shut up in a darkened shed for a day or

two. Should it show signs of fever and nervousness open the flap and syringe out the cavity again, closing the wound as before.

The trephine operation permits the operator to examine the brain more thoroughly and makes the removal of the entire parasite easier and more certain than is the case in the trocar operation. These things and the fact that it is easier to procure suitable instruments in this country make it more suitable for American sheepmen than the trocar operation.

In using the trocar outfit, shear the wool

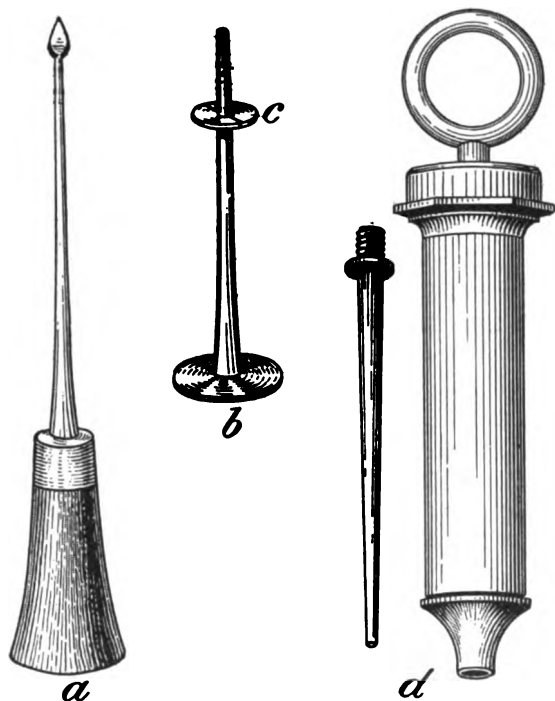


FIG. 14.—Instruments used in trocar operation. *a*, Trocar; *b*, cannula; *c*, guard (this is not present on most cannulas); *d*, syringe. (After Erdt, 1870, p. 88.)

from the area to be operated on and then shave a small place clean, using an antiseptic solution to disinfect the shaved area. Inject cocain under this. Insert the trocar (fig. 14*a*) in the cannula (fig. 14*b*). Drive the trocar and cannula carefully into the skull until it is evident that the skull is penetrated. They will go in very easily if the soft spot is struck. Most cannulas do not have the guard *c*, shown in figure 14, and care must be taken not to penetrate the brain too far. Withdraw the trocar, leaving the cannula in place. If the parasite is struck a flow of watery fluid should follow the withdrawal of the trocar. Insert the syringe (fig. 14*d*) in the cannula, and syringe out the fluid till no more will come. Then take off the syringe and withdraw the

cannula. The cannula should have a cleft at the end which is in the skull, and the parasite will often be caught in this. As the cannula is carefully withdrawn the parasite may be grasped with a pair of forceps and carefully drawn through the hole in the skull. Syringe out the cavity with a weak antiseptic solution as above directed till bleeding stops. Cover the whole with a pledget of cotton wrapped or sewed in gauze and soaked in the 3 per cent carbolic or the 1 to 1,000 potassium permanganate solution. Do not use pine tar or similar substances, as they do not permit of drainage. If the parasite is not struck the first time, a second or third spot may be selected and the trocar driven in.

The parasite should be destroyed. Burn it or put it in the strong antiseptic solution or in sheep dip. One sheepman told the writer that in operating on giddy sheep, and he had operated on quite a number, he threw the parasite away. This was almost the worst thing he could have done. The worst would have been to whistle for a sheep dog and feed it to the dog. That would have been only a little surer than throwing the parasite on the ground, as the two to ten sheep dogs around the home ranch of the average Montana sheep outfits would be almost certain to eat the parasite. Dogs sniff at such things out of curiosity, and eat them, perhaps, for the same reason. The writer has never yet seen a dog refuse to eat a bladder worm.

In passing, it should be said that all attempts to cure gid by the administration of medicine have proven failures. No cure of the sort is known.

ADMINISTRATION OF TAPEWORM MEDICINE TO DOGS.

As regards the administration of tapeworm medicine to dogs, many sheepmen think this is too much trouble, and many are puzzled by the names of strange medicines and unfamiliar terms of dosage. There are, however, some sheepmen who do give their dogs some tapeworm medicine. The best time to do this is after the outbreak of gid for the year is over and no more giddy sheep heads are available. This will usually be early in April, and in most seasons the dogs can be treated before being sent out on the summer range. This will eliminate the tapeworm before the advent of the rainy season starts the period of infection by washing the eggs onto the grass and into the drinking places. To safeguard against cases of gid which occur later than March, it would be a good idea to administer tapeworm medicine about four times a year, as new tapeworms develop from bladder worms in one or two months. This treatment could hardly be given while the dogs were on the range, and would require the temporary use of other dogs in order not to interfere with the herding. It is necessary that the dogs be tied up or confined while the medicine is given, in order that the tapeworms may be destroyed when passed.

The easiest and best way to destroy them is one which is used by a Montana sheepman. It consists in covering the worms and feces with a sufficient amount of hay or straw and burning them. Another way would be to bury the worms and feces with sheep dip, quicklime, or something of the sort. If the worms are put in some antiseptic solution, preferably formaldehyde or corrosive sublimate, and forwarded to the Bureau of Animal Industry, Washington, D. C., they will be identified and the sender notified as to whether they are gid tapeworms.

It is highly desirable that dogs should be treated for tapeworms. Not all dog tapeworms will cause gid in sheep, but they often develop injurious larval forms in man and the domestic animals, and they are all injurious to the dog. The fact that the dog belongs to the herder may be only an additional reason for insisting on giving it a dose of tapeworm medicine. The outbreak of gid in New York State was apparently derived from some dogs imported from Scotland, and it is altogether likely that dogs belonging to wandering sheep herders have brought gid from infected areas into many Montana flocks previously uninfected.

The following drugs may be used to rid dogs of tapeworms:

Pelletierine tannate. Very efficient, safe, and readily retained by the stomach.

Oleoresin of aspidium, or ethereal extract of male fern. Very reliable.

Kamala. Effective and convenient in that it acts as its own purgative as a rule. Sometimes advisable to follow by one of the purgatives mentioned later in this article.

Koussein, kussein, or brayerin. Very prompt and safe. Will act as a purgative, but should be followed by one of the purgatives noted below.

Areca nut. Good when freshly ground.

The dose for each of the above remedies is as follows: Pelletierine tannate, 5 to 15 grains; oleoresin of aspidium, 15 to 40 minims; kamala, 15 to 30 grains; koussein, 15 to 50 grains; areca nut, 20 to 50 grains. A sheep dog, weighing from 30 to 40 pounds, would require approximately the following amounts: Of pelletierine tannate, 10 grains; of oleoresin of aspidium, 30 minims; of kamala, 20 to 25 grains; of koussein, 30 grains; of areca nut, 35 to 40 grains.

For the purpose of the man who is unfamiliar with apothecaries' weights and measures, or who is in no position to weigh and measure in such fashion, the writer suggests that the drug desired, together with a box of No. 00 capsules, be purchased, and the amount of the drug be measured and administered in the capsule. There is a certain amount of variation in the amount of a powdered drug which can be placed in a capsule, owing to variations in the different lots of drugs, to variations of the same lot under varying conditions, and especially to variation in degree of compression. This is not of very great importance, however, as there is also a variation in the response to drugs of different dogs and of the same dog at different times. Give the 30 to 40 pound sheep dog 2 capsules full of pelletierine tannate, or 2 capsules

full of oleoresin of aspidium, or 2 to 2½ capsules full of kamala, or 5 capsules full of koussein, or 6 to 7 capsules full of areca nut. In the case of the powdered drugs the powder should be packed in the capsule by repeated tapping.

Where No. 00 capsules are not available when desired, other sizes may be purchased and the dose computed from the number of No. 00 capsules needed. The following table shows the relation of the No. 00 capsule to other capsules as regards capacity:

Number of capsule.....	00	0	1	2	3	4	5
Relative capacity.....	12	8	6	4	3	2	1

It is evident from this that it would take 12 times as many No. 5 capsules, 6 times as many No. 4 capsules, etc., of any drug as it would of No. 00 capsules.

Drugs should be purchased in small quantities and used while fresh, as they lose in strength and efficiency in most cases as they get older.

The method which the writer commonly employs in administering drugs to dogs is to push the capsule down the throat as far as possible with the right forefinger, working from the right side, while an assistant holds the dog with a piece of board in the left angle of the jaw to keep the dog from biting. Another way is to drop the capsules into the mouth and then hold back the head, keeping the piece of board in the angle of the jaw, and pour water in the mouth, holding the nose till the capsules are swallowed. Where it seems inadvisable to do these things, capsules may be fed in pieces of meat, or the drug may be fed in soup or milk, or in pills made up with honey and meal or molasses and meal.

The dog should be fed nothing but milk or left without food the evening before the medicine is to be given. It is sometimes advisable to give one or two grains of calomel at this time. The next morning administer the tapeworm medicine, but do not feed. Keep the dog shut up or tied up. If tied, it is advisable that a long rope be used, as some dogs object to defecating when tied with a short rope. After a couple of hours administer three to four grains of calomel, or one to two grains of podophyllin, or one to two drams of jalap, or a tablespoonful of magnesium sulphate. The calomel or podophyllin can be purchased in 1-grain pills of any druggist. Castor oil, in doses of an ounce or so, may be used, but is not recommended, for the reason that it appears in some cases to increase the solubility of the tapeworm medicine, all of which medicines are more or less poisonous, and so increases the likelihood of the medicine being taken into the dog's system with harmful or even fatal results.

The feces and worms should be burned with hay or buried with quicklime or sheep dip, as already advised.

As has been noted, the coyote probably carries the gid tapeworm. As the coyote can not be treated for tapeworms and is a difficult

animal to exterminate, it is evident that the most important measure in the elimination of gid is the destruction of the heads of giddy sheep.

FAVORABLE TIME FOR ERADICATION MEASURES.

The present is a particularly favorable time for the eradication of gid from Montana and thereby from the United States. The dry-land farmer is making his appearance all over Montana, and whether he will ultimately succeed or not, he has convinced a great many sheepmen that the end of the big range sheep industry in that State is in sight. Some have already gone out of business and others are planning to do so or at least to cut down their bands. For a time Montana will probably have fewer sheep and fewer sheepmen than for some years. Then if dry-land farming succeeds, the farmer will probably begin to raise sheep in small flocks, and there will be more sheep owners and perhaps more sheep than ever. In the meantime it is incumbent upon the Montana sheepman to do his share toward eradicating gid and saving his own bands and those of his neighbors from further loss on that score. An enlightened effort with very little expense or trouble, for two or three years, will leave a field clear of gid for the Montana sheep industry of the future, relieve the rest of the United States from the menace of such a disease within its borders, and in so doing eradicate from this country a disease which Europe has been unable to eradicate in more than half a century. In order that efforts at eradication may not be rendered ineffective through the importation of dogs infected with the gid tapeworm, the Secretary of Agriculture has issued an order, under date of November 25, 1910, providing that collie, shepherd, or sheep dogs imported into the United States be subjected to quarantine and inspection until the presence or absence of infection with this tapeworm can be ascertained.

In a recent article by Moussu (1910),^a he states that gid in France is looked upon as an accidental affair which ordinarily takes only one or two victims out of a flock, and so is looked upon as of no real economic importance. In comment he states that he has known gid to take 50 to 400 sheep from one flock, thereby proving itself a true disaster and killing off the entire lamb crop for the year. He further notes that breeders regard gid in such outbreaks as a mysterious disease of unknown nature. These two things, carelessness and ignorance, are quite probably the explanation of the failure to eradicate gid from Europe as they have been the explanation of the failure in this country. It is to be hoped that increasing care and interest in this subject will characterize the future conduct of the Montana sheepmen.

^a Journal d'Agriculture pratique, an. 74 (32), vol. 2, 11 août, pp. 175-177; (33), 18 août, pp. 213-215. Paris, 1910.

SUMMARY.

Gid has occurred in Montana for over twenty years and causes at times severe losses. It is usually confused with loco disease or other diseases. The losses and the history of the disease here and in Europe warrant prompt efforts at eradication.

The gid parasite, occurring as a bladderworm in the brain of the sheep, is transmitted to dogs by the latter eating the heads and brains of sheep dying in the last stages of gid. The heads on the bladderworm develop into tapeworms in the intestines of the dog, and the eggs formed by these tapeworms are passed onto the range or pasture and taken up by sheep in their food or water. From these eggs an embryo gets to the brain of the sheep and forms the gid parasite. There is absolutely no evidence to show that this life history of the gid parasite is incorrect.

The life cycle takes about a year for its completion and appears to be closely related to weather conditions. The weather and the nature of the forage appear to determine to some extent the amount of infection.

The symptoms of gid are very striking and readily distinguishable in most cases.

The eradication of gid is very easy. Destroy the heads or brains of giddy sheep, and keep sheep dogs and ranch dogs free of tapeworms. The first is the more important.

Destroy the heads by burning, or split the skull, scoop out the brains, chop them up or crush them, and cover them with turpentine, formaldehyde, or sheep dip. Ignorance and carelessness, resulting in leaving heads of giddy sheep to be eaten by dogs or coyotes, are responsible for the spread of gid in Montana.

Instead of killing giddy sheep and destroying the brain, the more favorable cases may be operated on if desired, taking care to destroy the parasite when it is removed from the brain.

Tapeworm remedies should be administered to dogs at least once a year when the outbreak of gid for the year is over. The medicines may be measured out in capsules in the amounts noted in the text. The tapeworms should be destroyed by burning or burying with quicklime or sheep dip.

The present is a particularly favorable time for eradicating gid from Montana and thus cleaning up the only area in the United States which is known to be thoroughly infected. Such eradication can only be accomplished by the care and interest of the sheepmen.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., November 14, 1910.

626.73
U58
B95c

UNIV. OF MICH.
APR 11 1911

Issued February 25, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 166.

A. D. MELVIN, CHIEF OF BUREAU.

THE DIGESTIBILITY OF CHEESE.

BY

C. F. DOANE,

Assistant Dairyman, Dairy Division,

IN COOPERATION WITH

THE OFFICE OF EXPERIMENT STATIONS.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; R. A. RAMSAY, MORRIS WOODEN, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

DAIRY DIVISION.

B. H. RAWL, *Chief.*

HELMER RABILD, *in charge of Dairy Farming Investigations.*

B. D. WHITE, *in charge of Dairy Manufacturing Investigations.*

L. A. ROGERS, *in charge of Research Laboratories.*

GEORGE M. WHITAKER, *in charge of Market Milk Investigations.*

ROBERT MCADAM, *in charge of Renovated Butter Inspection.*

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 26, 1910.

SIR: I have the honor to transmit herewith and to recommend for publication as a circular of this Bureau the accompanying manuscript entitled "The Digestibility of Cheese," by C. F. Doane, Assistant Dairyman in the Dairy Division of this Bureau. The work described in the paper comprised a thorough study of the food value of several varieties of cheese, particularly the American or Cheddar, under a great diversity of conditions. The experiments were carried out with human subjects with the cooperation of the Office of Experiment Stations of this Department. Two series of experiments were conducted, one at the Wesleyan University, Middletown, Conn., the other at the Minnesota State Experiment Station. Acknowledgment is made of assistance rendered by Dr. C. F. Langworthy, in charge of nutrition investigations of the Office of Experiment Stations, in preparing this work for publication.

Some important results were secured, particularly with regard to the popular theory that cheese, especially when green or unripened, is difficult to digest. The experiments proved conclusively that there is no warrant for this belief. The paper also presents some strong reasons for increasing the consumption of cheese by American people, both from the point of view of economy and for its superior food value. It is well known that at the present time the consumption of cheese in this country is far below that of European countries.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction.....	7
Experiments at Middletown, Conn.....	9
General plan of the work.....	9
Methods of sampling and analysis.....	10
Foods.....	10
Feces.....	12
Calorimeter experiments.....	13
Summary of results.....	13
Experiments at Minnesota Agricultural Experiment Station.....	15
General outline of the work.....	15
Description of samples.....	16
Summary of results.....	17
Cheese as an article of diet.....	19

THE DIGESTIBILITY OF CHEESE.

INTRODUCTION.

This report covers an exhaustive study of the food value and digestibility of American or Cheddar cheese in various stages of ripening. In addition, a few experiments were made with some purely foreign varieties of cheese.

The work, as first planned, was intended to be purely artificial digestion experiments. After these experiments were started it was found to be very advantageous to cooperate with the Office of Experiment Stations of this Department in a series of more thorough and valuable digestion experiments with human subjects. The artificial digestion experiments were continued, but as the results simply corroborated the results of the experiments with the human subjects the detailed consideration will be confined to the latter.

The experiments with the human subjects broadened the scope of the work, as they made it possible not only to determine the comparative digestibility of cheese at different stages of ripening, but also gave the opportunity to make a study of the food value of cheese and its effects on the health of the subject when eaten in comparatively large quantities.

The extent of the experiments and the uniformity of results have helped to settle questions which had been open to doubt, and about which some evidently erroneous opinions had been formed. A number of such questions had arisen, the most prominent of which concerned the comparative digestibility of green and cured cheese. The common American cheese was formerly eaten when it had gone through what is usually termed a ripening or breaking-down process in which some very evident but not thoroughly understood chemical and physical changes take place. The process may be described as a gradual change from a rubbery or elastic consistency to a mellow and partially soluble condition. This process, under the old way of curing the cheese in the factory where warm temperatures prevailed in the summer season, was accompanied by a decided development of flavor.

Associated with the idea that the green cheese was comparatively indigestible was another belief that curd or green cheese caused constipation. In fact, there was a popular idea that cheese at any stage

of ripening had a tendency to do this, though the unripened product was supposed to have the most pronounced effect.

It is perhaps a matter of some surprise that these beliefs, especially that of comparative digestibility, had become so thoroughly established, and it is natural to seek for the reason. As was noted, there is a marked difference in the physical characteristics of the green and cured products. The water-soluble material in well-cured cheese is noticeably high, while in the uncured product it amounts to almost nothing. It is very likely that these evident physical and chemical differences have been in a large measure responsible for the popular misconceptions. But it is a well-known fact that the solids of milk are very digestible and make an almost perfect food. With the addition of rennet and the development of lactic acid in the process of cheese making some chemical changes take place, but it is rather difficult to explain why these should transform digestible solids in milk into indigestible solids in cheese. A careful study also makes it difficult to comprehend why cheese of any sort, including green cheese, should have any unusual tendency to cause constipation. This is an almost universal belief among men who make and handle cheese. It is probably due to the fact that many people are very fond of the mild-flavored curd and eat large quantities of it when it is constantly at hand. The digestive disturbances which they attribute to peculiarities in the cheese itself are probably due merely to overeating.

Another interesting phase of the question centered about the actual value of cheese as a food. The opinion has been expressed by people who are sometimes considered as authorities on dietary subjects that cheese has no place as a staple food product, being of value only as a luxury or as a so-called appetizer. This is, of course, a view of the matter to which many would not agree, as we know that it forms a large part of the diet of many persons in Europe and elsewhere. In connection with the general question of food value, therefore, the economy of different varieties of cheese in the diet as compared with other highly nitrogenous foods is well worth consideration, as under the conditions which confront a large part of the laboring class a study of the economy of different foods becomes of the greatest importance.

Among many consumers and under usual American food conditions cheese is eaten largely as a relish. As such it is supposed to have certain properties as a condiment or as an aid to the digestion of other foods. This part of the question is also well worth investigating, and in this connection many varieties of cheese come up for consideration.

As a food product in the United States the common American or Cheddar cheese (the so-called "full cream" of the dealers) stands first in the quantity made and consumed. Emmental, or the so-called

Swiss cheese, is perhaps second, while on the basis of economy the different kinds of cheese made from skimmed milk, principally cottage cheese, are of great importance. From the standpoint of condimental value two other cheeses would be supposed to be of special importance. These are Camembert and Roquefort, two highly flavored and very distinct kinds. But they are comparatively expensive and are of such a nature that few people would care to eat more than a small quantity at a time.

The first year's cooperative work in the study of the food value of cheese was done at Wesleyan University, Middletown, Conn., where the Office of Experiment Stations had extensive laboratories and a respiration calorimeter for use in nutrition investigations with man. After the completion of the first year's work it was thought advisable to conduct some experiments with an older cheese than had been used in previous experiments, and also to study some foreign varieties. The second year's work was done in cooperation with the Minnesota State Experiment Station. Dr. F. G. Benedict and Mr. R. D. Milner had charge of the work done at Middletown, and Prof. Harry Snyder of the work in Minnesota.

THE EXPERIMENTS AT MIDDLETOWN, CONN.

GENERAL PLAN OF THE WORK.

The work at Middletown was planned to include green and ripe cheese, or cheese as soon after as it was made as it was possible to ship the samples to Middletown, and cheese in all stages of ripening up to the point where it was becoming unfit for consumption. The cheese was made in a cheese factory at Plymouth, Wis., and was kept in cold storage at Plymouth. Samples were shipped by mail as the plan of the experiments demanded. The cheese was made by the regular Cheddar process, was a little better than average quality, and would represent a large part of the cheese consumed in this country. The ripening of the cheese was carried on under different conditions. One lot was ripened under factory conditions where the temperature varied from 50 to 75° F. One lot was stored immediately and kept at 32° F. One lot was stored immediately and held at 40° F. One lot was held in the factory curing room for two weeks and then placed in a temperature of 40° F. and held. All the foregoing was made with low rennet, or 3 ounces of rennet extract to 1,000 pounds of milk. This entire series was duplicated with cheese made with 6 ounces of rennet extract to 1,000 pounds of milk. The greater quantity of rennet noticeably hastens the ripening process of the cheese. The smaller quantity is customarily used.

It might be well to state that the cheese made in this country at the present time is not as firm as the Cheddar cheese made many years

ago, as it very likely contains a greater percentage of moisture and ripens or cures more rapidly. It is often said that the old English Cheddar cheese is eaten at more than a year of age. At present cheese at six months of age is fit for food only if it has been cured and held in cold storage. Cold curing certainly retards the physical changes characteristic of a well-ripened cheese and also the development of flavor. Whether it affects the chemical changes which the cheese undergoes may be considered an open question.

The diet in these experiments consisted of a basal ration of whole-wheat bread and bananas, as these two articles have been thoroughly studied and the digestion coefficients have been determined. They are to be found in many of the publications of the Office of Experiment Stations. Each experiment extended over three days. A total of 184 experiments were made and a total of 65 human subjects were used. Many of these subjects were used in only one experiment, but one subject appeared in 14 experiments. The subjects were mostly students of Wesleyan University between the ages of 19 and 32 years.

METHODS OF SAMPLING AND ANALYSIS.

FOODS.

The diet in these experiments consisted of bread, bananas, and cheese in quantities calculated sufficient to give about 2,500 calories of energy and 20 grams of nitrogen per day.

Bread.—The bread was ordinary whole-wheat bread purchased from a local bakery. On the day before the experiment a large enough number of loaves were ordered to provide for all that would be needed on that day. On the morning of the experiment itself the crust was pared from all the loaves of bread. The required amount for the day was then weighed out upon a balance, and from each loaf of bread a slice or two was set aside as a sample. This plan was carried out on each of the three days in each series of experiments.

Bananas.—The bananas were obtained from a local fruit dealer, a bunch or more at a time. On the first morning of the experiment a number of bananas estimated to be large enough for the day were peeled, and immediately the required amount for each man was weighed out and set aside. From each banana used a sample slice or two was taken from the middle or the ends of the fruit.

Cheese.—The cheese arrived at the laboratory usually on the afternoon previous to the day on which the experiment began. It was unpacked immediately and a section estimated to be large enough for the amount to be used was cut from each cheese. This section was then cut into small pieces after the outside covering had been taken off and then was put through a small meat chopper. The

cheese thus ground was thoroughly mixed, and after being treated in this manner gave a material which could be readily handled and easily weighed. The required amount for each subject was then weighed as rapidly as possible upon a balance sensitive to a tenth of a gram. As soon as each portion was weighed it was immediately packed in a half-pint jar, sealed, and put away in a refrigerator. Instead of preparing the cheese for the experiments each day, enough was prepared on the afternoon previous to the experiment to last for the three days.

Sampling.—The method of sampling the foods used in the experiment was as follows: At the beginning of the series one-fifth of the total diet for the day was placed in an evaporating dish and dried in an oven. This was repeated on the second day, one-fifth of the total diet for that day being added to the sample of the previous day. This procedure was likewise carried out for the third day. The sample thereof consisted of three portions, which included one-fifth of the total amount of cheese eaten, one-fifth of the total bread, and one-fifth of the total amount of bananas. After the experiments had been in progress for several weeks it was found that this method did not give satisfactory results. Therefore it was decided to composite the bread and bananas alone, leaving out the cheese. A separate analysis of the cheese was made, as had been done all the way through the series.

Analysis of cheese.—Determinations were made on nitrogen, fat, and heat of combustion. All analyses for fat and nitrogen were made in triplicate. The nitrogen was determined according to the Kjeldahl method, using about 0.7 gram for each sample. The determination of fat was made according to the following method: Five cubic centimeters of a mixture of equal parts by volume of anhydrous copper sulphate and pure dry sand were placed in a glass extraction tube, and above this was placed the fresh cheese, about 3 grams being used for each determination. Above the cheese was placed a layer of dry fibrous asbestos. The extraction tube was then placed inside an ordinary straight glass tube which was connected to a flat flask and still. The material thus prepared was extracted for five hours; the extraction tube was then taken off and the material ground in a glazed mortar with the addition of a little fresh sand. The material was then washed back into the extraction tube by the aid of ether and the tube was placed on the apparatus and extracted for ten hours. The rest of the procedure was the same as in ordinary fat determinations.

The heat of combustion of the food was determined by means of the Atwater-Hempel calorimetric bomb. For each determination about 0.7 gram was taken and placed in a large-sized nickel capsule. This

was dried for about a day in a Hempel desiccator at very low pressure. Triplicate determinations were made in all cases.

Food composites.—Determinations on food composites for nitrogen, fat, and heat of combustion were made, and the methods used in these determinations were those employed by the American Association of Official Agricultural Chemists.

FECES.

Separation.—The method of separating feces employed in these experiments was that usually followed in the Wesleyan University laboratory. At the beginning of the breakfast on the first day of the experiment a gelatin capsule containing powdered charcoal was given to the subject and he was instructed to take that with the first part of his meal. The subject took another capsule with the breakfast of the first day after the end of the experiment. As the experiment progressed difficulty was experienced in separating the feces by this method, and two capsules were given to the subject instead of one. As a further aid in the separation at the end of the experiment a bunch of grapes was given with the breakfast of the first day after the experiment closed. The grape seeds being indigestible were very readily discernible in the feces, and they usually came before the appearance of the lampblack in the feces following that of the food experiment.

Drying.—The fresh feces were placed in a weighed dish (in these experiments an ordinary enameled cake pan was used), and the whole material was placed in an oven which ran at a temperature of 50 to 60° C. When the feces were partially dried other defecations were added to them, and each time they were placed in the oven after fresh feces were added. Upon the addition of fresh feces each time, 5 c. c. of 5 per cent hydrochloric acid was added. After all the feces for the experiment had been collected and the material was dry enough to be used, the pan and feces were taken out of the oven and allowed to come to air dryness, then weighed. This partially dried material was later analyzed.

Nitrogen.—The nitrogen in the feces was determined by the Kjeldahl method, as ordinarily carried out.

Fat.—At first the ordinary method for determining fat in food materials was used, but in connection with other experiments it was found that there was a marked difference between the fat extracted by ether with the ordinary method and that extracted by ether after the feces had been treated with hydrochloric acid and alcohol. Accordingly, in all the samples of feces in connection with these experiments the fat was determined by taking 2 grams of the material and placing it in a small porcelain evaporating dish. To the feces in the dish were added 10 c. c. of water and 2 c. c. of strong caustic soda. The mixture was then heated over a low flame for 10 to 20 minutes,

and the material stirred constantly at first. Enough strong hydrochloric acid was then added to the mixture to more than neutralize the sodium hydroxid which had been previously added. There were also added 10 c. c. of alcohol, and after the mixture was thoroughly stirred over the burner and evaporated on a hot plate until apparently dry it was placed in an oven and dried over night. The dishes were then taken out of the oven and the material allowed to cool. It was then ground with sand and transferred by means of spatula and rubbing with filter paper to special glass-extraction tubes. In this transferring, all of the filter paper used was added to the material in the tube. This was then placed in an ordinary extraction tube connected with a flat flask, and the material extracted with ether for 10 hours. In the extraction of this material by the above process finely divided particles were found in the extract which were not true fatty acids. So it was found necessary after the extraction was completed to filter the material in the fat flask into another weighed fat flask. In filtering, ordinary quantitative filters were used. The ether was then evaporated from that flask, and after drying one to two hours in an oven at 100° C. the material was weighed.

Heat of combustion.—The heat of combustion was determined in the usual manner by means of the Atwater-Hempel calorimetric bomb, described elsewhere.¹

CALORIMETER EXPERIMENTS.

In addition to the ordinary digestion experiments some experiments were made with the subject in the human calorimeter. For this, green cheese and thoroughly ripened cheese were used with the subject sometimes at rest and sometimes doing hard manual labor. The results showed that cheese, both green and cured, was in all respects a good food product, and the results checked up with the other digestion experiments.

SUMMARY OF RESULTS.

The results of the several digestion experiments in the different series are summarized in the following tables. In these tables the results are given for the digestion coefficient of the fat and the availability of the energy, both in the total diet and in the cheese alone.

The amount and exact composition of the basal ration used in the experiments is not given, for the reason that it varied in different experiments with the several subjects, and space will not allow its insertion. All of the data for the entire series of experiments are in the Office of Experiment Stations, Department of Agriculture, Washington, D. C., where they may be consulted by those who wish

¹Atwater and Snell. Journal of the American Chemical Society, Easton, Pa., 1903.

a more detailed account of the work. As previously mentioned, the basal ration was bananas and bread. The amount of cheese eaten per man per day varied somewhat, according to the appetite and preference of the subjects, but an average was not far from 0.5 to 1 pound per day. The exact amount eaten was in every case recorded, as were all other experimental data. While it is believed that the variations in the amount of the basal ration doubtless affected to some extent the digestibility of the cheese, it is thought best not to enter into this subject in this brief account of the work. From the character of the diet it will be seen that practically all of the fat and the greater part of the proteid came from the cheese.

TABLE 1.—*Results of digestion experiments with cheese cured in different ways added to a basal ration. Middletown experiments.*

Kind of rations.	Age of cheese.	Digestibility of proteids.		Digestibility of fat.		Availability of energy.	
		In total diet.	In cheese alone.	In total diet.	In cheese alone.	In total diet.	In cheese alone.
	Days.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Low-rennet cheese held at 60° F. added to basal ration of bread and bananas.....	1	88.1	99.4	92.8	95.8	90.9	91.6
	9	86.3	94.3	92.8	95.4	90.0	88.9
	16	88.6	98.3	94.9	97.4	90.8	91.3
	30	86.8	95.2	92.4	94.3	89.6	87.7
	44	88.6	97.0	95.2	97.3	91.2	92.1
	58	88.1	96.9	95.3	97.2	91.0	91.8
	93	91.0	100.6	96.2	97.9	91.8	93.9
	128	87.6	96.1	93.9	95.5	89.5	88.4
	156	90.7	100.3	94.8	96.4	90.7	91.4
	1	89.1	99.7	92.8	95.3	90.8	91.4
High-rennet cheese held at 60° F. added to basal ration of bread and bananas.....	9	88.7	98.7	95.4	97.9	90.5	90.4
	16	88.6	98.3	93.9	95.3	91.1	92.0
	30	85.5	92.6	93.1	97.1	89.2	86.5
	44	88.4	97.8	95.0	96.4	90.7	91.1
	58	87.4	94.7	93.9	97.0	90.3	89.8
	86	89.0	97.2	94.3	95.9	90.8	91.4
	115	90.0	100.5	92.6	95.0	90.0	89.6
Low-rennet cheese held at 40° F. added to basal ration of bread and bananas.....	142	91.1	100.4	94.5	96.1	91.1	92.5
	30	87.0	95.7	93.8	95.8	90.5	90.2
	44	88.1	96.2	94.4	95.4	90.8	90.9
	58	90.5	101.5	93.7	95.4	91.3	92.8
	30	87.8	97.0	92.5	94.5	90.3	89.7
Low-rennet cheese placed at 40° F. when two weeks old added to basal ration of bread and bananas.....	44	85.4	91.6	94.6	96.6	90.4	89.6
	58	89.4	99.6	95.3	97.1	91.4	93.2
	128	89.9	101.1	94.9	97.5	90.7	91.5
	155	88.9	98.0	94.3	95.9	90.4	90.7
	9	86.6	94.9	94.3	96.8	90.3	89.7
High-rennet cheese held at 40° F. added to basal ration of bread and bananas.....	16	87.1	95.4	91.7	93.1	90.1	89.3
	30	86.9	95.2	93.6	97.6	90.3	89.6
	44	88.0	97.2	94.0	95.3	90.8	91.3
	58	90.8	100.7	94.6	97.7	91.2	92.3
	30	89.4	99.7	94.7	96.8	91.3	92.6
High-rennet cheese placed at 40° F. when two weeks old added to basal ration of bread and bananas.....	44	90.4	101.8	95.2	96.6	91.5	93.5
	58	90.3	99.9	95.7	99.0	91.3	92.4
	115	89.9	101.2	94.5	97.2	90.5	91.0
	142	92.6	104.5	94.8	96.4	91.5	93.4
	9	90.3	102.1	94.7	97.4	91.2	92.5
Low-rennet cheese held at 32° F. added to basal ration of bread and bananas.....	30	86.0	93.9	94.2	96.2	89.9	88.4
	44	84.6	90.3	92.0	93.9	89.7	87.6
	58	88.1	97.3	94.8	96.6	91.2	92.4
	9	84.9	91.7	91.5	93.8	89.6	87.9
	16	89.7	100.4	92.7	94.1	90.9	91.6
High-rennet cheese held at 32° F. added to basal ration of bread and bananas.....	30	87.4	96.1	94.4	98.5	90.5	90.5
	44	89.5	100.1	94.5	95.9	91.2	92.7
	58	89.2	98.0	92.8	95.9	90.7	91.0
Low-rennet cheese, green curd, added to basal ration of bread and bananas.....		89.2	99.1	93.4	96.9	89.7	88.8

¹ This figure, as well as a number of others, shows that the digestibility of protein in the basal ration was evidently higher in these particular experiments than was assumed.

The results in the table show that there is little or no difference in the comparative digestibility of cheese at different stages of ripening. The perfectly green curd was evidently as digestible and, so far as nutritive value was concerned, was as good a food as the same cheese at any stage of ripening. The casein of cheese either fresh from the press or thoroughly ripened is very highly digestible. The cheese was eaten in comparatively large quantities, but it was evidently well assimilated.

A record of the health of each individual was kept, and also notes on the palatability of the cheese ration. At first 1,350 grams of bread were fed with 2,025 grams of bananas and 450 grams of cheese. The length of the experiment was three days, and this would make practically one-third of a pound of cheese per day. The bread was finally reduced to 1,200 grams and the cheese increased first to 525 grams and then to 600 grams for the three days. On the whole, the cheese was very palatable and, with a few exceptions, the amount given was not considered excessive by the person eating it. A number of the subjects wanted more of the cheese. The subjects of the experiments were about equally divided in the preference for a mild or a strong cheese.

Contrary to general belief, the green curd did not appear to cause constipation. In fact, constipation resulted more frequently after the cheese had had time to become well ripened. There also seemed to be more distress from the cheese diet with the well-ripened cheese than with the green cheese. On the whole, however, the cheese made a very satisfactory food. Fully as many instances were recorded of minor bowel disturbances corrected during the experimental period as of those which occurred during the same time.

EXPERIMENTS AT MINNESOTA AGRICULTURAL EXPERIMENT STATION.

As has been previously noted, during the year following the work at Middletown further experiments were made in cooperation between the Office of Experiment Stations and the Minnesota Agricultural Experiment Station. The primary object of these experiments was to study the digestibility of older cheese than had been previously used. In addition, the digestibility of other varieties of cheese was studied, as well as the so-called condimental value of some of the more highly flavored varieties.

GENERAL OUTLINE OF THE WORK.

The experiments included the following series of rations:

1. Old well-cured cheese in medium amounts, with bread and oranges.
2. Old well-cured cheese in large amounts, with bread and oranges.

3. Roquefort cheese in large amounts, with bread and oranges.
4. Green cheese in medium amounts, with bread and oranges.
5. Green cheese in large amounts, with bread and oranges.
6. Swiss cheese in medium amounts, with bread and oranges.
7. Skim-milk cheese in large amounts, with bread and oranges.
8. Camembert cheese in large amounts, with bread and oranges.
9. Camembert cheese in small amounts, with bread and oranges.
10. Roquefort cheese in small amounts, with bread and oranges.
11. Cottage cheese, with bread and oranges.

In order to determine the digestibility of the basal ration of bread and oranges used alike in all the trials with cheese, a number of digestion experiments were made with bread and oranges alone, bread and oranges with milk, and bread and oranges and butter.¹ It is to be noted that in these digestion trials and the trials with cottage cheese an opportunity was offered for determining the influence which the milk fat and the casein had alone and in combination upon the digestibility of the ration.

In all the experiments the conditions were alike, and the result of one experiment is strictly comparable with the results of the others. The subjects employed were university students, who were engaged a part of the time at light manual labor. Four subjects were used in each experiment and the same four subjects were used in each series.

In all the digestion trials the experimental period was three days. A preliminary meal preceded the experiment proper and at the close an additional meal was eaten; this enabled the feces for the experimental period to be carefully separated.

The methods of the Association of Official Agricultural Chemists were used for the analyses of the food materials and feces. The fat of the feces was also determined by a modified method that had been used in the experiments at Middletown. In the calculation of the digestion coefficients the results of the modified method were used except in a few cases where the results were evidently too high, and where the calculated calories using the association's results checked more closely with the determined calories than when the modified fat results were used.

DESCRIPTION OF SAMPLES.

Most of the bread was made in a small home bakery and the remainder at the experiment station laboratory in connection with other experiments. The old cheese was from the same lot, made for the Middletown experiments, and was about 18 months of age, having

¹ The details of these experiments are not given in this paper, but it is planned to publish them in a fuller report of this work by the Office of Experiment Stations of this department, and anyone desiring to make a more detailed study of the experiments can consult this larger publication when it appears.

been kept in cold storage for the entire period. It was thoroughly broken down, high flavored, and was pronounced to be of excellent quality.

The skim-milk cheese was evidently not a so-called full skim, but from the composition must have been what is usually termed a two-thirds skim, as the cheese contained 11 per cent of fat. It was purchased on the Chicago market. The green cheese was furnished by a factory in Minnesota. The other cheeses were bought from wholesale dealers in St. Paul, Minn.

SUMMARY OF RESULTS.

The results of the Minnesota experiments are shown in the following table:

TABLE 2.—*Results of digestion experiments with cheese of different kinds added to a basal ration. Minnesota experiments.*

[In each case the value represents the average of experiments with four subjects.]

Kind of ration.	Digestibility of nitrogen—		Digestibility of fat in total diet. ¹	Availability of energy—	
	In total diet.	In cheese.		In total diet.	In cheese.
Old cold-storage cheese (435 grams added to basal ration).....	<i>Per cent.</i> 92.53	<i>Per cent.</i> 91.79	<i>Per cent.</i> 91.04	<i>Per cent.</i> 92.33	<i>Per cent.</i> 86.13
Old cold-storage cheese (585 grams added to basal ration).....	93.79	96.36	93.64	92.21	87.08
Green cheese (750 grams added to basal ration).....	94.39	96.29	89.96	92.29	86.45
Green cheese (1,050 grams added to basal ration).....	94.33	95.83	93.72	91.25	86.40
Roquefort cheese (520 grams added to basal ration)...	93.13	93.57	91.04	92.40	87.15
Swiss cheese (605 grams added to basal ration).....	92.67	92.19	90.84	92.00	84.38
Skim-milk cheese (1,000 grams added to basal ration)...	95.10	96.65	88.55	90.47	79.68
Camembert cheese (605 grams added to basal ration)...	91.65	88.65	89.17	92.87	83.59
Camembert cheese (240 grams added to basal ration)...	91.07	83.22	80.86	92.25	74.95
Roquefort cheese (295 grams added to basal ration)...	90.82	82.59	88.70	92.41	82.18
Cottage cheese (540 grams added to basal ration).....	92.85	92.68	.....	.....	90.98

¹ Because of the fact that the basal ration of bread and oranges is practically free from fat, the digestibility of the fat in the total diet and in the cheese alone may be considered to be identical.

In the discussion of the results and the interpretation of the digestion coefficients it is believed that the calories should be taken as the indirect index of digestibility of the fats rather than the fat determinations.

In the calculation of the results it was assumed that the bread and oranges had the following digestibility: Protein, 93 per cent; carbohydrates, 98 per cent; calories, 98 per cent.

As so little fat was contributed by the bread and oranges, it was deemed best by Prof. Snyder, under whose direction the tables of results were prepared, not to make any special calculations for the digestibility of the fat of the cheese alone.

The factor for the digestibility of the protein of the bread and oranges is higher than was found in the numerous experiments for

bread alone, but it was assumed because it appeared from the first series of results that cheese in the ration increased the digestibility of the protein of the other foods. This assumption appeared to be verified by the later tests which had for their special object the influence of the cheese upon the digestibility of the basal ration.

The work both at Middletown and in Minnesota, while demonstrating the same general fact of the high food value, actual and comparative, of cheese in all stages of ripening, does not give identical figures for the digestibility of protein in the total diet or in the cheese. A different basal ration was used in the Minnesota experiment from that used at Middletown. White bread was used in Minnesota, while whole-wheat bread, which has a decidedly lower digestibility, was used in the experiments at Middletown.

Nothing unusual was noted in the health of the subjects used in the experiments at the Minnesota Experiment Station. One of the subjects believed before beginning the experiments that a cheese diet did not agree with him, but found that it had no ill effects.

In considering the results shown in Table 2 it is apparent that all the kinds of cheese used in the experiments are very digestible. In comparing the old cheese with the green cheese the latter was evidently the more digestible, which was not the case in the Middletown experiments, where the slight difference was in favor of the well-cured cheese. However, the difference between the digestibility of green and cured cheese in either series of experiments is well within the limits of variation ascribable to personal peculiarity of the subjects and were to be expected in this kind of work.

Particular interest attaches to the evident digestibility and food value of the skim-milk cheese. This is a product which has not been viewed with very great favor by the public in general. The physical properties of cheese made from skimmed milk have been such as to give consumers the impression that it was indigestible and, on the whole, of questionable value as food. The establishing of the actual food value of this comparatively cheap product will at some future time doubtless be of great economical importance. Skim-milk cheese made up in a way to be agreeable to the taste could be sold at a price that should attract the attention of the laboring classes. Cheese made from skimmed milk and sold for whole-milk cheese is a fraud that is a positive injury to the dairy business; but cheese made from skimmed milk and sold for what it is is worthy of serious consideration on the part of both producer and consumer. It is very likely that the time is not many years distant when a comparatively large quantity of cheese from skimmed milk will be made with profit to the dairy industry and will be consumed at a pronounced saving by the laboring class in general.

In the same connection attention is called to the food value of cottage cheese established by this work. This is another cheap and to many a very palatable product that could be introduced to a much greater extent in the dietary at a great saving in the total cost of food.

In general, the table shows that all kinds of cheese, even the very high-flavored and so-called condimental cheeses, have a high food value. But the so-called condimental value of cheese when eaten in small quantities as a stimulus to the digestion of other foods was not demonstrated. Where the cheese was eaten in small quantities the digestibility of the basal ration fell below the assumed digestion coefficient. The fact that in the work done at Middletown the digestibility of the basal ration was increased in many cases at least is no evidence that cheese has any particular properties as a stimulant to digestion as it has been shown that other foods, such as meat, might have the same effect. This is a physiological phenomenon that may perhaps be explained on some other basis than that of condimental effects.

CHEESE AS AN ARTICLE OF DIET.

While the experiments herein described have established the facts as to some debatable questions concerning the comparative digestibility of green and cured cheese, perhaps the most valuable result has been in showing clearly the great value as food of all the more common varieties of cheese.

The Swiss, who are a very healthy people, eat largely of cheese; in fact, bread and cheese form the greater part of the diet of many of them. Many other European races eat largely of cheese. The miners of England consume very much of the poor cheese made in the United States, especially the high-acid cheese, using it extensively for seasoning; and the Germans eat large quantities of the cheap but highly flavored skim-milk cheese such as the hand käse, which has perhaps the most pungent odor of all the varieties of cheese made.

In the matter of comparative food values it was thought that the results of the experiments given in this report made it safe to assume that cheese was as fully digested as most of the ordinary food materials which have been studied in earlier experiments carried on in connection with the nutrition work of the Department. It would in fact be undesirable for a larger per cent of any food material to be absorbed than was the case with the cheese.

Heretofore cheese has seldom been regarded seriously by consumers of any class in the United States as a possible cheap staple food. All consumers of cheese with very few exceptions use it as a luxury in small quantities at comparatively rare intervals. While in the aggre-

gate a large quantity of cheese is eaten in the United States, the quantity is nevertheless almost negligible when compared with some other products of less food value and inferior palatability.

The greater part of the cheese consumed in this country is eaten without any preparation, while in many European countries the cheese is either sprinkled on other foods—vegetables usually—or is cooked with the food. Americans evidently have much to learn from Europeans of some of the possibilities of preparing such dishes. A number of European varieties of cheese are made extensively and exclusively for use in connection with other foods or in cooking. Among these is the well-known Parmesan, a hard cheese made from skimmed milk; and also the sap sago cheese, a small conical-shaped cheese made from skimmed milk and highly seasoned with herbs. The Italians use cheese for flavoring as Americans use salt and pepper, having it grated and constantly at hand in a small shaker. With them macaroni with cheese is a common dish, as are other cheese preparations. An excellent dish is the cheese omelet, while warmed-up potatoes can be made very appetizing when cooked with cheese.

It may be, perhaps, that the American people have gone so far in the consumption of only partly ripened and mild-flavored cheese that the probabilities of learning to use cheese as a flavoring are very remote, as it is only the well-ripened or highly flavored cheeses that are satisfactory for flavoring purposes. It is perhaps a matter for some regret that so much mild-flavored cheese has come to be used, as it is probable that much more satisfaction would be felt by consumers in general with this great food product if they had learned to like the well-ripened product with a well-developed flavor. It is generally conceded that people who like a highly-flavored cheese never become tired of it.

A comparison of the food value of cheese with that of other highly nitrogenous food materials may be of interesting value. No kind of meat excepting dried beef carries such a large percentage of protein as cheese, and as dried beef contains a much greater percentage of water, the other food constituents aside from the protein are much less than is found in cheese. Fresh beef as purchased has, weight for weight, little more than half the food value of cheese in either protein or fat, and the same is true of practically all other fresh meats, which have in many cases such a large percentage of refuse and in all cases such a large percentage of water that they are noticeably inferior to cheese in food value. Bacon or fat pork are exceptions, but their food value is mostly in the fat, which can be and is replaced to a great extent by the carbohydrates of vegetables at a much less cost and sometimes perhaps at a benefit to the health of the consumer.

Fish and pork each have a notably large percentage of refuse, while eggs have a high percentage of water. To sum the matter up, a pound of cheese has nearly the same food value as 2 pounds of fresh beef or any other fresh meat as food; it is worth as much as or more than a pound of ham and is more digestible, and it is equal to 2 pounds of eggs or 3 pounds of fish. In price good cheese made from unskimmed milk costs about a third more than round steak and twice as much as the cheaper boiling beef, while it costs practically the same per pound as smoked ham and bacon. It costs usually a third more than fresh fish.

Cottage cheese or cheese made from partially skimmed milk is cheaper even than the American of Cheddar cheese. The first costs about one-third as much and the partly skimmed product, about two-thirds as much as the so-called "full cream" cheese. Practically the only food product that rivals cheese in food value and cheapness is dried beans.

In view of the foregoing comparison of food values it is a matter of some wonder why there is not more of a demand for cheese, especially by people of limited means. Estimates made by the Department of Agriculture, in the Twenty-second and Twenty-sixth Annual Reports of this Bureau and in Bulletin 55 of the Bureau of Statistics, show that the people of the United States consume between 169 and 185 pounds of meat annually per capita, besides fish and poultry, while the annual consumption of cheese is only about 4 pounds per capita. Even granted that fresh meats are more palatable to most people, some other explanation must be found for this wide difference in the quantity of the two products eaten. A great proportion of the laboring class in this country are able to eat plenty of wholesome food, but they can not afford to discriminate against a cheap, palatable, and wholesome food in favor of a higher-priced food. The only way to account for the comparatively limited demand for cheese is on the basis of custom and lack of knowledge. People usually eat what they have been accustomed to, making variations within narrow limits only, and never changing the general character of their food. New foods are not sought.

In this connection particular interest attaches to the quantity of salt or cured pork products eaten in comparison with cheese. Cured pork, ham, and bacon, to about seven times the value of cheese are eaten annually. No one can say that the pork products, with the exception of good ham, are more palatable than cheese, and they are not known to be more healthful. These pork products are usually eaten by the poorer classes who can not afford to buy fresh meat but who could afford to buy cheese, and cheese makes a better food in the dietary, because of its high protein content.

Cheese can no longer be discriminated against because of a suspicion that it is not a healthful food. The absolute lack of any disturbance of the general health of the subjects used in the experiments reported in this bulletin is proof that cheese can be eaten in large quantities without danger to health. The Swiss cheesemakers, also many of the Swiss farmers of southern Wisconsin, eat unusually large quantities of cheese, and they are noted for athletic attainments and physical endurance. They brought the custom of eating cheese from their native country, where cheese is a very important item in the diet. The consuming public, especially that part of it which needs to practice economy in buying food, would do well to turn its attention a little more toward cheese, since greater quantities can be used at a saving to the consumer.



636.073

458

1395c

Issued June 30, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 167.

A. D. MELVIN, CHIEF OF BUREAU.

657

THE DIMETHYL SULPHATE TEST OF CREOSOTE OILS AND CREOSOTE DIPS; A SUBSTITUTE FOR THE SULPHONATION TEST.

By ROBERT M. CHAPIN,

Senior Biochemist, Biochemic Division.

INTRODUCTORY.

In the examination of coal-tar creosote dips, used or offered for use for the official dipping of sheep,¹ the Biochemic Division of the Bureau of Animal Industry has confronted a problem which is commonly set before chemists engaged in the testing of commercial creosote oils, namely, to determine whether any particular sample of oil may be classed as a strictly legitimate coal-tar creosote distilled from gas tar or coke-oven tar, or whether it is probably derived wholly or in part from tars of other origin. The test here to be described has been in use in the laboratories of the Biochemic Division for nearly two years and has been found a helpful aid in arriving at certain data which are generally considered to be of much value in determining the source of origin of creosote oil.

THE SULPHONATION TEST.

The rationale of the sulphonation test has been thoroughly explained and discussed by the Forest Service of this department.² Briefly the process consists in treating a measured amount of a certain "cut" of the oil with hot concentrated sulphuric acid. Aromatic hydrocarbons are thereby sulphonated and the sulphonic acids pass into solution in excess of sulphuric acid, allowing the unattacked paraffin hydrocarbons to rise to the surface as a distinct oily layer of which the volume may be measured in an appropriate apparatus. The proportion of the residue thus isolated is notably different in different classes of creosote oils and so may serve as an aid to their classification.

The theory of the sulphonation test is simple and rational, but its execution, especially in inexperienced hands, is sometimes unsatisfactory and always rather tedious and disagreeable.

¹ Bureau of Animal Industry Order 143, regulation 33.² Forest Service Circular 112, The Analysis and Grading of Creosotes.

THE DIMETHYL SULPHATE TEST.

Some years ago Valenta¹ stated that dimethyl sulphate is miscible with all proportions of aromatic hydrocarbons, while it does not at all dissolve hydrocarbons of the open-chain series, and but slightly dissolves rosin oil. In order, then, to estimate tar oil as an adulterant in petroleum oil or any of its products, or in rosin oil, according to Valenta it was simply necessary to shake thoroughly a measured portion of the oil with a measured portion of dimethyl sulphate in a graduated glass cylinder and to note the resultant increase in volume of the dimethyl sulphate. Valenta cited several experiments on mixtures of various oils to show that the process yielded reliable results.

Valenta's test has been critically examined by Graefe² and by Harrison and Perkin,³ and the following points appear well established:

1. Aromatic hydrocarbons and derivatives thereof are completely soluble in dimethyl sulphate, being miscible in all proportions.

2. Open-chain hydrocarbons show varying degrees of solubility in dimethyl sulphate, ranging from zero to a considerable percentage, light oils as a rule being the more soluble.

3. Treatment of a mixture of aromatic and open-chain hydrocarbons with dimethyl sulphate results in the formation of two layers; the upper contains most of the open-chain hydrocarbons plus a varying but usually small amount of aromatic hydrocarbons retained in solution; the lower layer contains practically all of the dimethyl sulphate, holding in solution most of the aromatic hydrocarbons plus a varying but usually small amount of the open-chain hydrocarbons.

The test therefore is no absolutely quantitative one, as indeed is to be expected from the laws of solubility. Results obtained thereby may, however, under favorable circumstances, closely approach quantitative values, and so may prove very useful for practical work.

APPLICATION OF THE DIMETHYL SULPHATE TEST TO CREOSOTE OILS.

Valenta's object was to determine the amount of tar oils as adulterants in paraffin oils and rosin oils. The purpose of applying the test to creosote oils is the reverse of Valenta's, namely, to determine

¹ Valenta, E. Ueber die Verwendung von Dimethylsulfat zum Nachweis und zum Bestimmung von Teerölen in Gemischen mit Harzölen und Mineralölen und dessen Verhalten gegen fette Öle, Terpentinöl und Pinolin. *Chemiker-Zeitung*, Jahrgang 30, 1st Semester, p. 266-267. Cöthen, March 28, 1906.

² Graefe, Ed. Ueber die Valenta'sche Reaktion. *Chemische Revue über die Fett- und Harz-Industrie*, Jahrgang 14, Heft 5, p. 112-115. Hamburg, May, 1907.

³ Harrison, T. W., and Perkin, F. M. The action of dimethyl sulphate upon oils of the aromatic and aliphatic series. *Analyst*, vol. 33, no. 382, p. 2-11. London, Jan., 1908.

open-chain hydrocarbons when present in tar oils.¹ The test really lends itself better to the latter purpose, for the aliphatic oils remain behind in tangible form, and so may be directly estimated and readily submitted to further examination.

Since it appears evident from work above referred to that the test will yield the most accurate results when applied to mixtures of heavy oils or oils of high boiling points, the first step in applying it to a creosote oil will be to fractionally distill the oil and apply the test to one of the higher fractions, thus rendering the results comparable to results afforded by the sulphonation test as carried out by the Forest Service. Ordinarily in this laboratory 5 c. c. of the fraction is pipetted into a narrow 25 c. c. burette and shaken with 8 c. c. of dimethyl sulphate after closing the burette with a smooth close-fitting cork. Separation of the residual oil occurs in a short time in the form of a clear, almost colorless, supernatant liquid layer.

The following table illustrates the parallelism between results afforded by the two methods. The distillations were performed from an ordinary fractionating flask with a side tube about halfway up the neck. Temperatures were taken, uncorrected, by a 16-inch thermometer graduated to 360° C.

TABLE 1.—Comparative residues afforded by sulphonation and dimethyl sulphate tests.

Kind of oil.	Temperature of fraction.	By sulphonation on 10 c. c.	By dimethyl sulphate per 10 c. c.
	° C.	c. c.	c. c.
Commercial coal-tar creosote so-called "crude carbolic acid, 20 per cent".....	240 to 270	0.2	Trace.
	270 to 330	0.47	0.86
Blast-furnace creosote.....	240 to 270	1.60	2.00
	300 to 350	2.00	3.20
Oil-gas-tar creosote.....	240 to 270	2.10	3.70
	300 to 350	2.35	4.80

Evidently results obtained by the dimethyl sulphate test are parallel with those yielded by the sulphonation test, and though quantitatively differing from the latter, will probably afford data equally as valuable for the purpose of judging the source of origin and the composition of samples of commercial creosote oils. At any rate, until extended experience has shown more fully the range of difference between the results of the two processes the dimethyl sulphate test may serve as a useful "sorting test," leaving the sulphonation test

¹ Although this application of Valenta's test appears sufficiently obvious, yet at the time the manuscript of the present paper was submitted by the writer, several months before publication, the literature on the subject of creosote oils which had come to hand had contained no mention of it. It is now, however, necessary to notice in this connection a paper by Charles N. Forrest, entitled "The characteristics of creosote and tar oils available for wood preservation," appearing in the *Journal of the Society of Chemical Industry*, 1911, vol. 30, p. 193.

4 DIMETHYL SULPHATE TEST OF CREOSOTE OILS AND DIPS.

to be employed as a check in the more doubtful or important cases. The test certainly yields quick, clean, and definite results even in wholly inexperienced hands, and requires but a minimum of apparatus and manipulation.

APPLICATION OF THE DIMETHYL SULPHATE TEST TO CREOSOTE DIPS.

Bureau of Animal Industry Order 143 requires that coal-tar creosote dips offered for use in official dipping shall contain rosin soap as the emulsifying agent. Since rosin oil is but partially soluble in dimethyl sulphate, and since highly heated rosin decomposes with the formation of rosin oil, the dimethyl sulphate test can not be applied to the highest distilling fractions of a material containing creosote oil and rosin. To show the effect of rosin upon the amount of residue obtained the following experiments were performed:

Experiment 1.—One part of rosin was dissolved in 3 parts of the commercial coal-tar creosote previously examined with the results noted in Table 1. The material was then fractionally distilled and certain fractions were tested, with the results shown in Table 2.

TABLE 2.—*Tests of fractions from mixture of coal-tar creosote and rosin.*

Temperature of fraction.	Sulphonation residue on 10 c. c.	Dimethyl sulphate residue per 10 c. c.
° C. 240 to 270 270 to 305	c. c. 0.96	c. c. Trace. 2.12

Experiment 2.—A dip prepared from the same creosote, using about 1 part of rosin to 3 parts of oil was fractionally distilled and certain fractions tested, with the following results:

TABLE 3.—*Tests of fractions from distillation of coal-tar creosote dip.*

Temperature of fraction.	Dimethyl sulphate residue per 10 c. c.
° C. 240 to 270 270 to 300	c. c. 0.20 2.52

A comparison of the results afforded by the foregoing experiments with those noted in Table 1 indicates that both the dimethyl sulphate test and the sulphonation test may be consistently applied to mixtures of creosote oil and rosin—that is, to dips—provided the tests are

applied to a fraction distilling between 240° and 270° C., but that neither of the tests is applicable to fractions distilled at a temperature much above 270° C. and approaching 300° C. In practice the test may be combined with the determination of the percentage of water in the dip¹ by providing the distillation flask with a thermometer, using 100 grams of dip, and continuing distillation until a fraction at 240° to 270° C. is obtained. Dimethyl sulphate residues obtained by this method are indicated by Experiment 2 to be somewhat high, hence for more accurate values a method parallel to Experiment 1 is preferable. In such case about 150 grams of dip is well shaken in a separatory funnel with 30 to 40 c. c. of dilute sulphuric acid (1 to 2). After about an hour the lower layer is drawn off as completely as possible, loss of some of the upper layer of course being immaterial. The residual oil is brought into a flask, neutralized with powdered calcium carbonate, and dried by warming with CaCl_2 . It is then passed through a folded filter and about 100 c. c. of the material which now contains only oil and rosin is subjected to distillation.

The limitation of the temperatures at which the fraction may be taken evidently allows the recognition of blast-furnace or oil-gas creosote, although the residues obtainable from the lower fractions of such creosotes are notably smaller than those yielded by fractions distilled at a temperature near to or above 300° C. The most serious drawback to the limitation of the temperatures of distillation lies in the fact that it renders entirely possible a failure to detect the admixture with a coal-tar creosote of certain quantities of high-boiling petroleum residues.

If a sample of a coal-tar creosote dip is shaken in a separatory funnel with ether and caustic-potash solution in proper amount a separation into two layers will result. The upper ethereal layer may be washed with potash solution and water, the ether distilled off, and the hydrocarbons present in the dip, now freed from rosin acids and tar acids, will be thus rendered susceptible to thorough examination. The extraction may, of course, be rendered nearly quantitative if desired. The extraction of sufficient oil to allow of fractional distillation will naturally be a somewhat tedious operation and will involve the use of considerable quantities of ether. It seemed desirable, therefore, to determine if the tests might be applied directly to the oil so separated and without previous distillation.

Experiment 3.—Hydrocarbons were extracted from the dip prepared from the sample of commercial coal-tar creosote already described and were tested with dimethyl sulphate with an absolutely

¹ See Bureau of Animal Industry Bulletin 107, "The Analysis of Coal-Tar Creosote and Cresylic Acid Sheep Dips," page 10.

negative result. To another portion of these hydrocarbons was then added paraffin oil and the mixture tested, with the following results:

TABLE 4.—*Tests on mixtures of paraffin oil with hydrocarbons extracted from dip.*

Nature of mixture.	Sulphonation residue on 10 c. c.	Dimethyl sulphate residue per 10 c. c.
Dip hydrocarbons with no addition.....		0.00
2½ volume per cent of paraffin oil.....		.40
5 volume per cent of paraffin oil.....	0.00	.80

Although the hydrocarbons from the dip when treated alone with dimethyl sulphate afforded absolutely no residue, yet the mixtures of paraffin oil and dip hydrocarbons yielded residues considerably greater than the additions of paraffin oil warranted.

The explanation must lie in the fact that the layer of paraffin oil extracted from the dimethyl sulphate layer some of the oils therein dissolved in the first case, possibly nonsaponifiable constituents of rosin, as well as the small amounts of paraffinoid oils indicated by previous tests to be present in the original creosote oil. Hence while the absence of a dimethyl sulphate residue indicates the practical purity of the creosote employed in the preparation of a dip, the method obviously can not be employed for more than approximate estimations of either added foreign creosotes or added petroleum oil.

In practice, then, the examination of a creosote dip will be carried out as follows: Between 20 and 50 grams of dip, depending upon the character and scope of the subsequent examination, is treated with ether and caustic potash solution and the ethereal extract of neutral oils distilled or evaporated to complete removal of ether and moisture.¹ The residue is then examined by the dimethyl sulphate test as previously described. If the result is negative² it is certain that the dip contains neither any large amount of creosote of doubtful origin nor petroleum oils. If the result of the test is positive and further information is desired a sample of the dip may be subjected to distillation in one of the two ways previously described and a test made on the fraction distilling between 240° and 270° C.

¹ Detailed directions for the quantitative separation of coal-tar oils and rosin acids are given in Bureau of Animal Industry Bulletin 107. In the present case the extraction ordinarily need not be quantitative, but it is necessary to free completely the ethereal solution of neutral oils from rosin acids.

² The supernatant layer of oil is sometimes rather dark and may not be easily distinguishable. In such a case it will usually be evident if looked for by reflected instead of transmitted light, or if present in very small amount it may be brought into the narrow neck of the burette just above the stopcock by carefully running out the dimethyl sulphate layer, and is there more readily observed.

CAUTION IN THE USE OF DIMETHYL SULPHATE.

Valenta notes that dimethyl sulphate possesses poisonous properties and hence must be used with a certain amount of care. Lassar-Cohn¹ cites cases of death caused by the material and specifically cautions against allowing it to come in contact with any considerable surface of the skin and against inhaling the vapors. The caution is necessary for the reason that the substance presents an innocuous appearance and its chemical composition would not lead one to expect it to possess particularly poisonous properties. However, employed as here indicated, little danger is to be apprehended, for the quantity used is small, and it is not subjected to heat. Obviously a pipette must never be employed for transference of the substance. Altogether the process appears far less likely to be accompanied by accident than is the sulphonation test, which involves considerable manipulation of comparatively large quantities of hot concentrated sulphuric acid.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *May 17, 1911.*

¹ Lassar-Cohn. *Arbeitsmethoden für organische-chemische Laboratorien*, vierte Auflage, spezieller Teil, p. 298. Hamburg and Leipzig, 1907.



Issued February 16, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 168.

A. D. MELVIN, CHIEF OF BUREAU.

A NOTE ON THE FEEDING VALUE OF COCONUT AND
PEANUT MEALS FOR HORSES.

By GEORGE M. ROMMEL, *Chief of Animal Husbandry Division,*

AND

W. F. HAMMOND, *Superintendent Morgan Horse Farm.*

During the early part of 1910 a short test was made at the Morgan Horse Farm of the Bureau of Animal Industry, near Middlebury, Vt., to observe the effect of substituting for oats in feeding horses a mixture of two parts coconut meal and one part peanut meal, by weight. Ten Morgan yearlings and four heavy work horses were used.

Three yearlings (Lot I) were fed as a check lot on the usual ration, which included a variety of grain feed, as well as whole oats, ground oats, and hay. Three yearlings (Lot II) were fed the same ration, except that the coconut meal and peanut meal replaced one-half the oats and no old-process linseed meal was fed. Four yearlings (Lot III) were fed the same ration as Lot I, except that all the oats were replaced by the mixture and no old-process linseed meal was fed. Two work horses (Lot IV) were fed as a check lot on the usual ration of oats (whole and ground), corn, bran, and hay, and two others (Lot V) were fed the same ration as Lot IV except that the coconut and peanut meal mixture replaced the ground oats, which amounted to about one-half the oats fed.

On account of the excessive contract prices for oats during the last fiscal year a considerable saving in the cost of the ration was expected. Whole oats cost the farm \$43.75 per ton delivered at the farm, and coconut and peanut meal \$28 per ton, delivered at the railroad station, 2 miles from the farm.

The yearlings were started on one-fourth pound per day each of the mixture, an equal amount of other feed being replaced. The work horses received one-half pound per head daily at first. None of the horses took to the coconut and peanut meal ration eagerly, and the work horse team so fed was off feed during the first three weeks. Aside from these instances, no difficulty whatever was experienced, and the horses were reported in good condition.

The test began on February 7, 1910, and closed on May 31, 1910. Weights were taken on three days at the beginning and end, namely, February 5, 6, and 7 and May 30 and 31 and June 1, the average of these weights being taken as the true weights at the beginning and close.

The yearlings on coconut meal and peanut meal showed somewhat larger and cheaper gains, those having all their oats replaced giving the best returns. Lot I averaged 468 pounds at the beginning and 576 pounds at the end, showing an average daily gain of 0.95 pound. Lot II averaged 471 pounds at the start and 594 pounds at the close, making an average daily gain of 1.08 pounds. Lot III averaged 492 pounds at the beginning and 623 pounds at the close, making an average daily gain of 1.15 pounds. The condition of the yearlings was good during the entire test. The cost of feed per 100 pounds gain was as follows: Lot I, \$15.33; Lot II, \$13.39; Lot III, \$12.02. Lot III ate quite a little more feed than the others.

Results were fairly satisfactory with the work horses. Both teams worked 898.5 hours during the test. Lot IV, on the ordinary ration, gained 60 pounds in weight during this time, and Lot V, on the coconut-meal and peanut-meal ration, gained 20 pounds. There was a little saving in cost of feed, that of Lot IV costing \$81.17 and that of Lot V costing \$77.10, the cost per 100 working hours being \$9.03 and \$8.58, respectively.

This test seems to indicate that at the prices paid for feed at the time coconut and peanut meal, in the proportion of 2 pounds to 1, can replace oats in the ration of young horses and may be found advantageous for work horses after they have become accustomed to it.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *January 12, 1911.*

[Cir. 108]



630,073
U 58
B 95c

U. S. DEPARTMENT OF AGRICULTURE, 169

BUREAU OF ANIMAL INDUSTRY—CIRCULAR

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY;
UNIV. OF MICH.
JUN 18 1911

A STUDY OF SURRA FOUND IN AN IMPORTATION OF CATTLE, FOLLOWED BY PROMPT ERADICATION.

BY

JOHN R. MOHLER, V. M. D.,

Chief of the Pathological Division,

AND

WILLIAM THOMPSON, M. D. C.,

Veterinary Inspector, Bureau of Animal Industry.

[Reprinted from the Twenty-sixth Annual Report of the Bureau of Animal Industry (1909).]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

ORGANIZATION OF THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

CONTENTS.

	Page.
Preliminary remarks.....	81
History of the importation.....	82
Previous importations.....	84
The characteristics of Indian cattle.....	84
Appearance of surra in the United States.....	85
The causative agent of surra.....	86
Nature of the disease.....	88
Prompt eradication of the disease.....	91
Rabbit experiments with infected blood.....	93
The rôle of the Tabanidæ in the transmission of surra.....	94
Conclusions.....	97

ILLUSTRATIONS.

PLATES.

	Page.
PLATE I. Fig. 1.—A zebu bull of the Borden importation, in quarantine. Fig. 2.—Two zebu calves of the Borden importation, in quarantine..	84
II. Fig. 1.—A zebu bull of the Borden importation, on the ranch in Texas. Fig. 2.—A zebu bull whose blood was found to be infected with the trypanosome of surra.....	88
III. Horse showing swollen and edematous condition of extremities, sheath, and under surface of abdomen on nineteenth day of disease.....	88

TEXT FIGURES.

FIG. 1. Corral with location of cattle therein	83
2. <i>Trypanosoma evansi</i> , the cause of surra.....	87

A STUDY OF SURRA FOUND IN AN IMPORTATION OF CATTLE, FOLLOWED BY PROMPT ERADICATION.

By JOHN R. MOHLER, V. M. D., *Chief of the Pathological Division,*

AND

WILLIAM THOMPSON, M. D. C., *Veterinary Inspector.*

PRELIMINARY REMARKS.

About thirty years ago a number of the so-called Brahman cattle of India were introduced into southern Texas by A. H. Pierce, a stockman of Pierce, Tex. These animals were crossed with our domestic cattle, and the resulting influence on the herds was markedly apparent. One of the most interesting observations was that their progeny remained relatively free from ticks while other stock in the same pastures would be literally covered with these pests. The cattle ticks are present in such enormous quantities in this section of Texas as to make cattle raising much less profitable than it should be. This is due not so much to the fact that these ticks carry the Texas-fever micro-organism as to their great blood-sucking powers as external parasites. The Brahman grade cattle appear likewise to be less affected by other parasites and pestiferous insects such as mosquitoes, hornflies, gadflies, etc., and to withstand better the warm, dry climate and other semitropical conditions present in the gulf coast section of the United States than do the native cattle. Since this first importation by Mr. Pierce the Indian strain of blood has gradually deteriorated, and after his death one of the executors of the estate, Mr. A. P. Borden, requested a permit from this Department to make a further importation of Indian cattle for the Pierce ranch with the view of restoring this strain of blood.

It was claimed that the cattle on the ranch which had some Brahman blood in them were as a rule in good flesh, while the native cattle were in poor flesh and had to be fed in winter. They were likewise found to be less subject to the prevalent diseases of this section. However, while it is evident that Brahman cattle have their usefulness in semiarid localities, it is not believed that they will ever be considered important factors in our live-stock industry, for reasons that will appear elsewhere in this article.

In consequence of Mr. Borden's representations and his desire to introduce other cattle from India in order that the breed might be replenished and continued in Texas, the Secretary of Agriculture consented to allow him to make an importation from that country.

HISTORY OF THE IMPORTATION.

Appreciating the great danger to our live stock connected with the bringing of animals from India, on account of the very dangerous contagious diseases which prevail there and their general dissemination, the Department required the strictest possible precautions to prevent the introduction of any of these contagions. Dr. William Thompson, a veterinary inspector of this Bureau, who had served two years in the veterinary service of the Philippine Islands, was detailed to go to India to inspect the animals before purchase, to inquire into the history of the cattle as far as possible, and to accompany them on the steamer to the United States, his expenses being paid by Mr. Borden. Full and complete instructions were given both for microscopic examinations and for animal inoculations of the blood of these cattle, and strict orders were furnished to use the utmost vigilance in making inspections, and to accept no animals from any infected locality. Furthermore, it was stipulated that in case any infectious disease should be discovered after the animals had been collected for shipment the entire number should be considered as exposed and rejected. On this side a special isolated place for their quarantine was provided, and arrangements were made to transfer the cattle on arrival from the steamer to a barge by which they were to be transported to Simonsons Island, adjoining Staten Island, where they were to be kept in special quarantine for an indefinite period. This island is located on the Fresh Kills, a tributary of Staten Island Sound, about a mile from New Jersey, and separated from Staten Island by wide salt marshes subject to tidal overflow, so that the cattle would not touch the mainland until released from quarantine.

On March 31, 1906, Doctor Thompson and Mr. Borden met at Bombay and proceeded to Miraji, where 22 very fine bulls of the Krishna Valley breed were purchased. This section was reported to be free from rinderpest, surra, contagious pleuro-pneumonia, foot-and-mouth disease, and all other contagions. These cattle, in order to prevent their exposure on the way, were shipped in clean and disinfected cars to the government agricultural farm at Poona, where arrangements had been made to isolate the animals until ready for shipment from Bombay. Other purchases were made at Ahmadabad, where 9 head of range bulls of the Guginjurat breed were obtained, while 6 others of the Nellore breed were secured from Madras. The remainder of the importation, which altogether included 46 bulls, 2 cows, 1 heifer, and 2 calves, of seven different breeds, were selected in lots of one and two at various points along the route and then shipped to the Poona agricultural farm.

At Poona microscopic examinations of the blood for trypanosoma were made on two different occasions, as it was impossible to do so

prior to purchase owing to the prejudice of the Hindus. On account of the reported existence of rinderpest in other parts of West India it was considered advisable to inoculate all the animals with anti-rinderpest serum, and this work was carried out in order to guard against any unforeseen exposure during loading or detention in Bombay, or from feed and forage. From Poona the cattle were shipped in disinfected cars to Bombay, where they were conveyed by means of a loading chute directly from the cars to the steamer. Unfortunately, it was impossible to obtain rabbits for inoculation purposes in Bombay, nor could nose rings be purchased, and for these reasons no animal inoculations were made until the cattle reached the United States.

No indication of any disease being apparent in the cattle, and the history regarding the presence of any infectious disease in their places of origin being negative, the animals were shipped from Bombay on April 27 for Hamburg, where they were transhipped on June 2, arriving in port at New York on June 16, 1906, seven weeks after their departure from Bombay. They were transferred

from the Hamburg-American steamer directly to a large barge by means of a cage and derrick, being hoisted from the steamer and lowered directly to the barge deck. The barge was then towed to Simonsons Island, which had already been prepared for the purposes of quarantine. A corral 100 feet square, constructed with 6 by 6 inch posts and 2 by 6 inch rails, had been erected with uprights joined to support a tarpaulin, which was used as a shelter from the sun and the rain. The 51 head of cattle were placed side by side on the east and south sides of this inclosure, as shown in figure 1. The cattle were stabled without accident, and appeared to be in very good condition on physical exam-

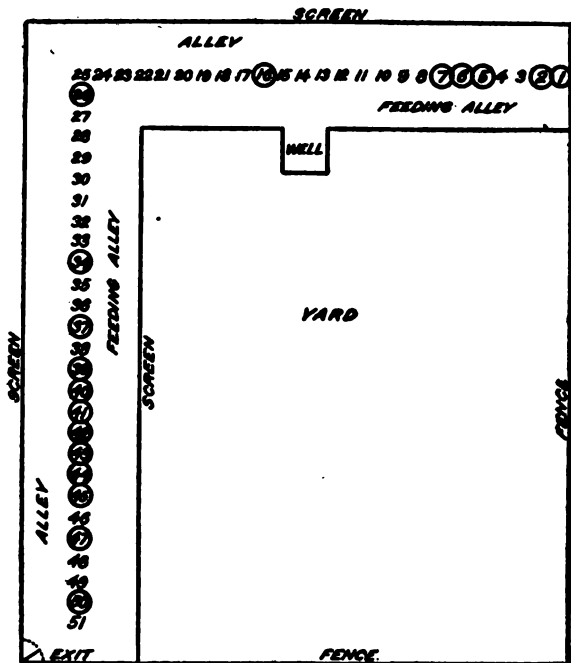


FIG. 1.—Corral with location of cattle therein. Circles around numbers indicate those animals which harbored the surra trypanosome.

ination. As the regulations of the Department provided for the tuberculin testing of all bovines imported into the United States, the cattle were subjected to this test as soon as they had thoroughly recovered from their sea voyage (June 29 and 30), but in no instance was any reaction obtained.

PREVIOUS IMPORTATIONS.

Brahman cattle were probably first introduced into the United States in 1849 by Dr. J. B. Davis, of South Carolina. Some additional importations for agricultural purposes followed, but such shipments were stopped in 1884 on the promulgation of an order of the Department of Agriculture issued under the act of Congress prohibiting importations of cattle from abroad without first obtaining a permit from the Department. After that time, until the Borden importation of 1906, no permits were granted to import Brahman cattle except for zoological gardens and menageries.

THE CHARACTERISTICS OF INDIAN CATTLE.

It will probably be of interest to mention briefly a few characteristics of this breed of cattle (*Bos indicus*), described in works on natural history as zebu and popularly known as Brahmans, or the sacred cattle of India. It is not uncommon to observe these animals in zoological gardens and circuses, but the majority of the sacred cattle on exhibition are of the smaller breeds, weighing about 250 pounds and standing not higher than 3 feet. On the other hand, the types of Indian cattle selected for this importation were of the larger breeds, standing as high as 6 feet and weighing up to 1,860 pounds. They are distinguished from our native cattle principally by the loose fold of skin at the navel, an immense hump on the withers, long, pendulous ears, large and loosely hanging dewlap, and an excessive fullness of the throat. There is a more lengthened form of the head, with a concave line of profile, a mild, sleepy eye with a look of latent power frequently displayed, arched neck, and long, tapering legs. The horns are dark, short, but thick at the base, and point upward and backward; the hips are narrow, and the rump slopes rapidly from the sacrum to the tail. (See Pl. I.)

The sebum secreted by the sebaceous glands of the skin has a peculiar odor which seems to be repugnant to insect life. The hide, while it may be as thin as in our domestic animals, still appears to be much tougher and is more difficult to penetrate with a hypodermic needle. The hair is quite short and does not provide favorable shelter for the development of ticks. These three factors are probably responsible for the slight amount of tick molestation which these animals experience.

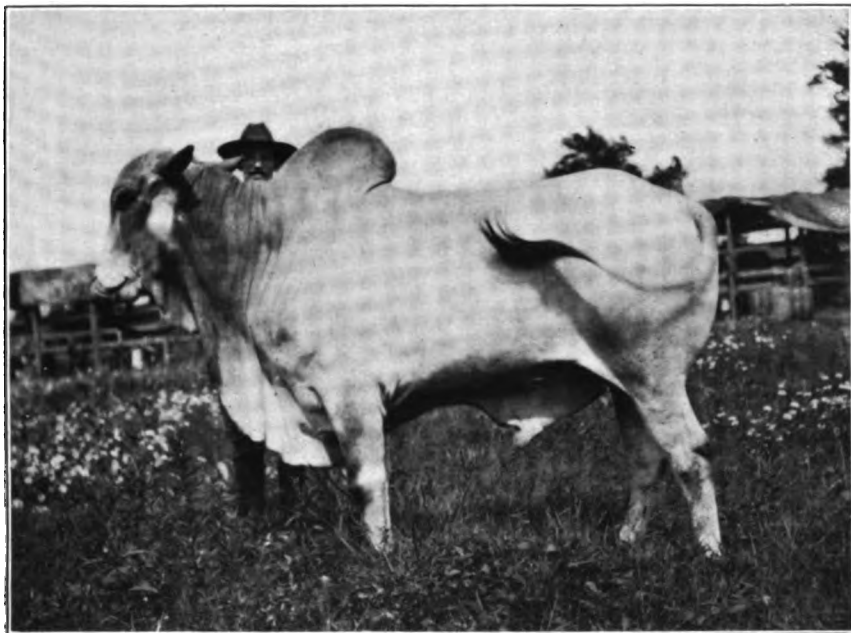


FIG. 1.—A ZEBU BULL OF THE BORDEN IMPORTATION, IN QUARANTINE.

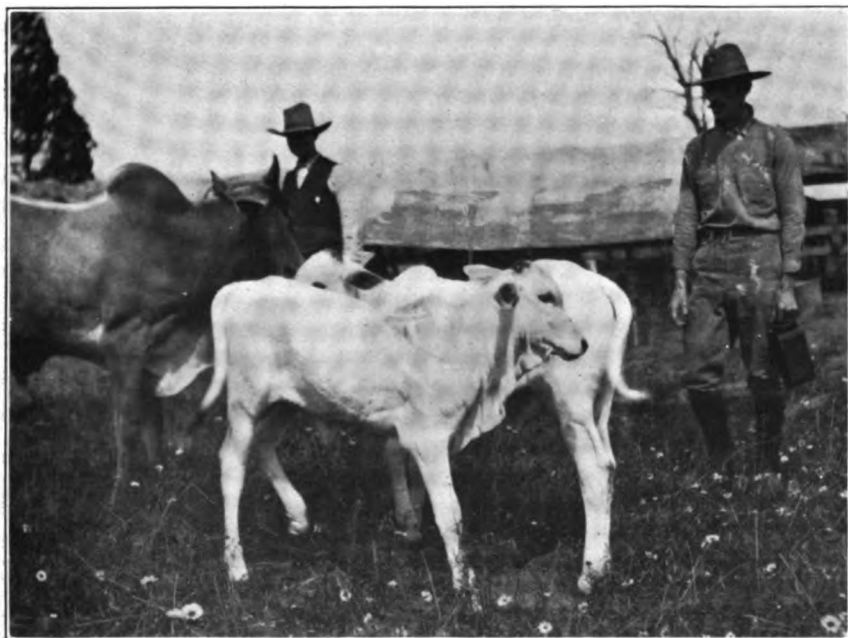


FIG. 2.—TWO ZEBU CALVES OF THE BORDEN IMPORTATION, IN QUARANTINE.

The color of the Brahman cattle is chiefly light silver gray, with dark shadings of the fore and hind quarters. (See Pl. II, fig. 1.) However, the color varies much according to the breed, some being red, while others are white, and the albino bulls constitute the so-called sacred bulls of India, which play a very important part in certain religious festivals. Among the Hindus the zebu is believed to have a charmed life. They venerate this animal and hold its slaughter to be a sin, though they have no scruples about working it. While the Brahmans are classed as a distinct species, they cross readily with our domestic animals. In India these animals are not only reared for milk and flesh, but are also extensively employed as beasts of burden. They are likewise used for both riding and driving, having great powers of endurance. The hump is considered the most delicate part of the carcass for food, and is usually prepared in pickle, like tongue. The cows sometimes yield a fair amount of milk, but it is low in butterfat.

APPEARANCE OF SURRA IN THE UNITED STATES.

Despite the fact that the blood of all the Indian cattle in the Borden importation had been examined microscopically on two occasions at Poona, and twice again during the ocean voyage en route to New York, with negative results, it was deemed advisable and a necessary precaution to make the more exacting test of rabbit inoculations before accepting the cattle as free from the surra parasite.

With this end in view a sufficient number of rabbits were taken to Simonsons Island and one rabbit was inoculated with the blood from each animal. Cover-glass preparations were likewise made at the same time for examination of the fresh, unstained specimens. These blood inoculations were commenced on July 5 and 6 by the inoculation of 49 rabbits with the blood of adult cattle, the two calves not being tested at this time.

The method of taking the blood and injecting the rabbits for this and all subsequent tests was as follows: Each zebu was secured by a nose ring or halter to a head rail, the hair on the margin of the left ear clipped, and the tissue toward the tip of the lower margin washed and disinfected with carbolized water, dried, and the ear then whipped by the hand to render the blood vessels turgid. A small vessel near the margin was then nicked with the point of a knife and 5 to 8 c. c. of blood obtained in sterile bottles, each containing a sufficient quantity of potassium citrate solution to prevent clotting. When necessary the hemorrhage was arrested by the use of a figure-8 suture after sufficient blood had been obtained. After each operation the knife and hands of the operator were washed in a 5 per cent solution of carbolic acid. Identification cards were made out for each rabbit, to which a number was given corresponding to the num-

ber of the animal from which the blood was taken, and 2 c. c. of this blood was injected subcutaneously into the rabbit on the inner side of the thigh. The syringe used for this purpose was disinfected after each injection with 5 per cent carbolic acid and then rinsed with sterile water.

A few days later the temperatures of the rabbits were taken. Following the first inoculation tests, rabbits Nos. 16, 39, and 42 showed a marked rise. The blood of each rabbit was then examined microscopically, and the *Trypanosoma evansi*, the causative agent of surra, was demonstrated on the ninth day in rabbit No. 16, and on the tenth day in rabbits Nos. 39 and 42. (See fig. 2.)

It is our opinion, which appears to be confirmed by the following notes, that in all probability there were only these three infected zebus at the time of the arrival of the cattle in quarantine, and that the others became subsequently infected by means of the plague of flies present that summer in the vicinity of Staten Island.

The seriousness of the appearance of surra in the United States being apparent to all interested parties, the question of preventing the landing of any of the cattle was carefully considered, with the result that it was finally decided to kill and burn all the infected cattle and to make repeated blood tests of the remaining animals under proper precautions until it was absolutely proven that the infection had been entirely eradicated. As the importer, Mr. Borden, was at that time in Texas, a delay of several days was occasioned awaiting his arrival, but the killing and burning of the three infected cattle was accomplished on July 20.

THE CAUSATIVE AGENT OF SURRA.

It has been definitely shown by numerous experimental observations that surra is caused by the presence of the *Trypanosoma evansi* in the blood. This fact was first reported by Dr. Griffith Evans in 1880, and since then has been confirmed by many other investigators. The parasite is a flagellate protozoan 20 to 30 μ long, 1 to 2 μ broad, and approximately spindle-shaped in outline. (See fig. 2.) Each organism has a somewhat pointed posterior extremity, while the anterior extremity narrows into a long, wavy flagellum. The organism moves, as a rule, with the flagellum end forward, owing to the rapid lashing of this whip-like extremity and by the contractions and relaxations of the body. The micronucleus or blepharoplast or centrosome is prominently located near the posterior end and is connected with the flagellum by a distinct line passing along the free border of the undulating membrane, which is along one side of the parasite like a fin. The nucleus is near the anterior end. Multiplication takes place by longitudinal division only, the centrosome being

the first to begin dividing. The division of the nucleus follows, as a rule, the flagellum remaining attached to one of the resulting halves, while a new flagellum develops on the other half.

The parasite is transmissible from infected to healthy animals by biting flies, and perhaps by other agencies. Owing to its large size and active motility it is readily detected in a film of fresh unstained blood with the low-power lens of the microscope. At first there is noticed an intermittent and characteristic agitation of some of the red cells, and upon focusing in the vicinity of this motion there will soon emerge to view a minute, eel-like organism two or three times as long as the diameter of the red cell, actively moving between the blood cells. It appears in the blood in swarms, so that the examination of the blood at one time may give negative results, while a similar examination made earlier or later may give positive results. The organism, however, is invariably found during the paroxysms of the disease in both experimentally and naturally acquired surra. When such blood is filtered through bougies the filtrate is not pathogenic, proving that the trypanosome is withheld by the filter.

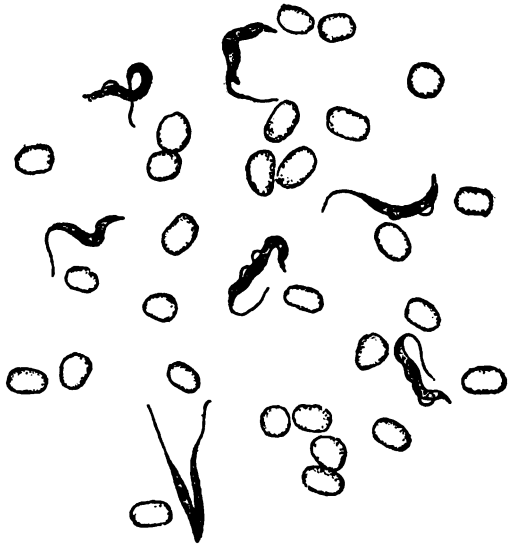


FIG. 2.—*Trypanosoma evansi*, the cause of surra.
(From Zebu No. 44.)

The disease may likewise be transmitted from one susceptible animal to another through a long series, and in each instance the trypanosome may be observed during the febrile attack by microscopic examination. Even during the intermission when the blood appears to be entirely free of the trypanosomes the inoculation of rabbits will, as a rule, result in the production of the disease. All attempts that have been made in the laboratory of the Pathological Division to cultivate the organism on the blood-agar medium of Novy, as well as by other methods, have been without result, although the cultivation of certain other species of trypanosome (*T. lewisi* and *T. equiperdum*) has been accomplished.

The exact method by which these parasites interfere with the health of the infected animals has not as yet been established.

NATURE OF THE DISEASE.

The term "surra" was given to this disease by the natives of India, and was adopted by Evans, Lingard, and others on account of its appropriateness. The word "surra," by which the disease has since been universally known, was used by the natives to describe anything withered or rotten, such as a decayed carcass. They applied the term loosely to all those chronic ailments of a devitalizing character which had no specific designations. The name was thus very comprehensive, and was applied to this specific disease of animals because there is a marked withering or falling off in condition without sufficient post-mortem lesions to account for it. It is a disease of the Far East, and has prevailed in certain sections of India for generations. It has been reported from the Persian Gulf, Korea, Egypt, Syria, Algeria, Zululand, Java, Borneo, Madagascar, Mauritius, Burma, China, the Philippine Islands, and other places.

Surra is a specific, communicable febrile disease occurring in horses, mules, asses, camels, elephants, dogs, and rats, and capable of being transmitted by inoculation to cattle, buffalo, sheep, goats, rabbits, guinea pigs, and monkeys. It is due to the presence of a specific flagellate parasite in the blood, the *Trypanosoma evansi*, named after its discoverer. The fever is of an intermittent, remittent, and sometimes relapsing type, and continues for varying periods from a few days to months, depending upon the animal attacked and its physical condition at the time. In solipeds the disease generally assumes an acute type and causes death in a relatively short time, while in camels the disease is of a chronic type and the animal may live for months or even years, frequently recovering if the disease lasts for three years. The blood of cattle may swarm with the trypanosome without apparent harm, although the animals may become very thin and anemic for a time, after which they, as a rule, recover, though they occasionally die. The great danger from infected cattle, however, is in the possibility of the infection being carried from the apparently healthy cattle to the highly susceptible horse, mule, or ass by flies or otherwise. The period of incubation is usually about six to eight days after the exposure, although the disease may develop in from two to seventy-five days.

All available evidence seems to indicate that the most common method of transferring the trypanosome of surra from infected to uninfected animals is by means of insects, particularly the biting flies. Infection may likewise take place through an abraded wound on the body becoming contaminated with infectious blood. Thus dogs and cats with abrasions of the mucous membrane of the digestive tract may contract the disease by eating the flesh of horses which have died of surra. Saddle galls, summer sores, and similar lesions on otherwise healthy horses may likewise become infected by birds

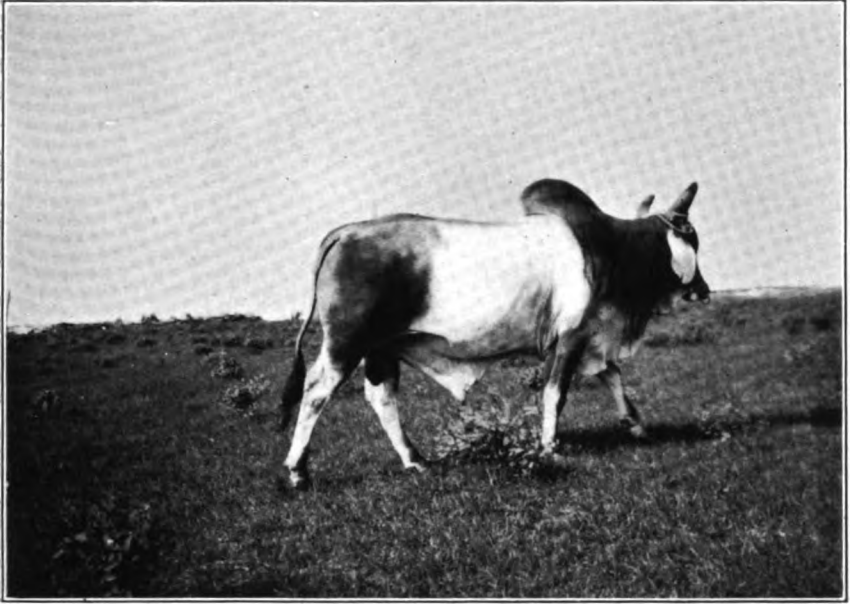


FIG. 1.—A ZEBU BULL OF THE BORDEN IMPORTATION, ON THE RANCH IN TEXAS.

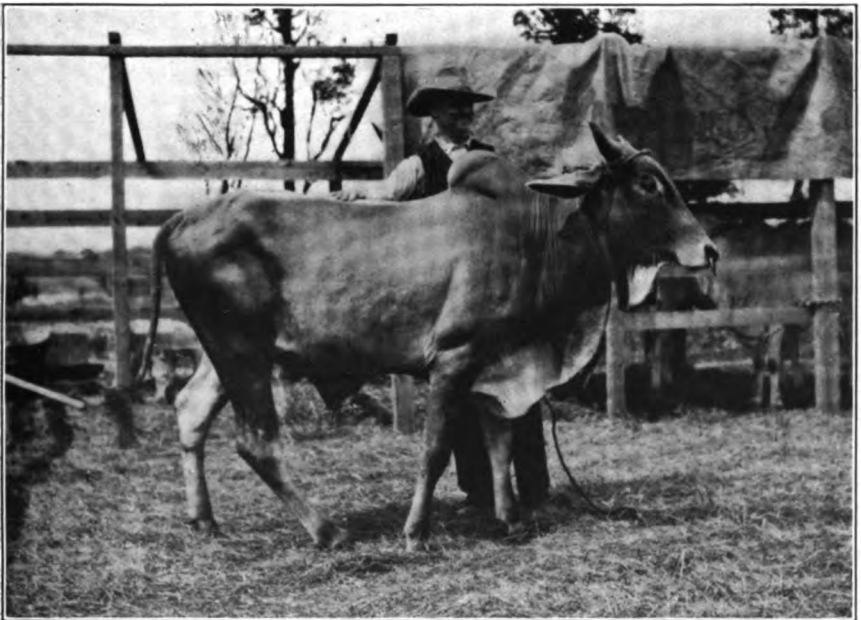
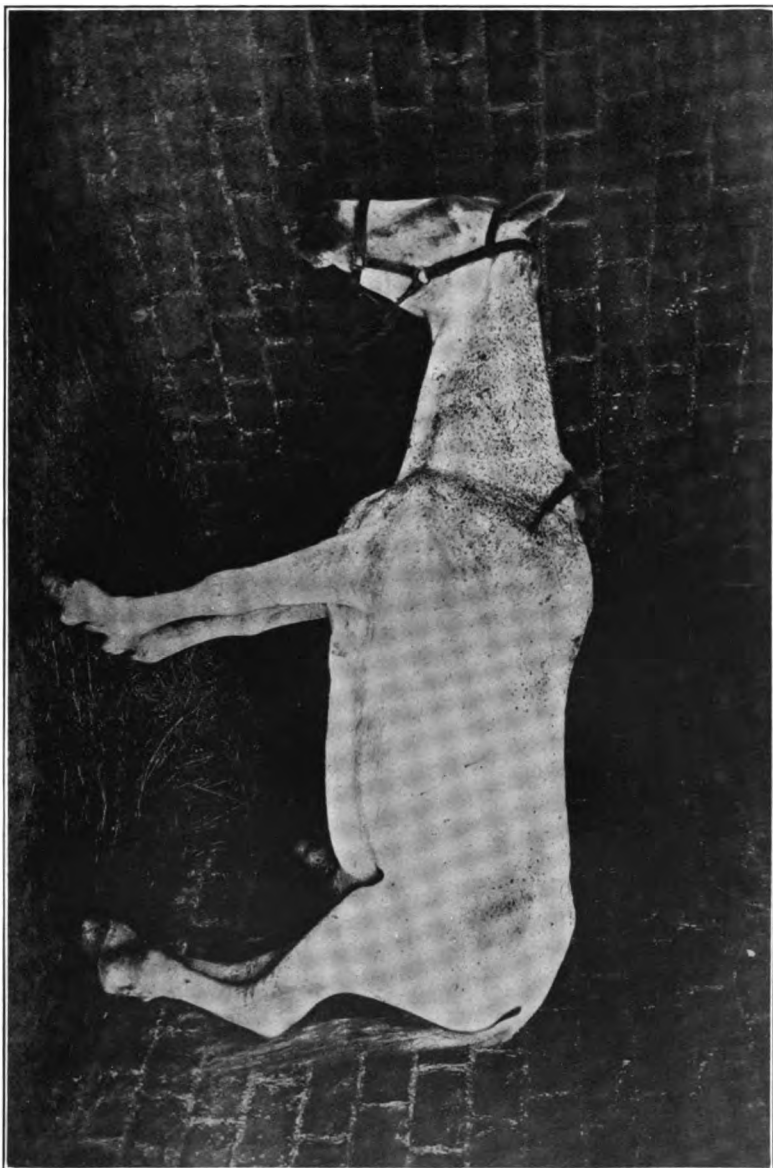


FIG. 2.—A ZEBU BULL WHOSE BLOOD WAS FOUND TO BE INFECTED WITH THE TRYPANOSOME OF SURRA.



HORSE, SHOWING SWOLLEN AND EDEMATOUS CONDITION OF EXTREMITIES, SHEATH, AND UNDER SURFACE OF ABDOMEN, ON NINETEENTH DAY OF THE DISEASE. (AFTER LINGARD.)

and insects which peck or feed on them after having previously soiled their beaks or probosces on infected animals or carcasses. Drinking stagnant water and eating grass or other forage grown on recently inundated land are popularly regarded as being methods of infection with surra, but the experimental proof to support such opinions is lacking. Stiles has probably given the correct interpretation of this theory by drawing attention to the fact that biting flies are generally numerous around inundated pastures and stagnant water, and therefore a great number of possible transmitting agents of the disease are in these localities.

In the outbreak of surra here recorded it was quite definitely proved that the infectious principle was carried from animal to animal by the large breeze fly, *Tabanus atratus*, and by no other species of fly or other kind of insect; nor did contact exposure, the use of the same drinking buckets, etc., play any part in the spread of the infection.

According to Lingard,⁶ the chief symptoms in the horse are an intermittent, remittent, and sometimes a relapsing type of fever which continues for a varying period from a few days to several months. Closely following the first rise in temperature there is the occasional appearance of urticarial eruption, which may make its appearance at any time during the course of the disease. Then follows the presence of petechiæ on the mucous membranes, chiefly those covering the membrana nictitans; also nasal, ophthalmic, vaginal, and other mucous discharges, and the exudation of a yellow semigelatinous material in the subcutaneous and other connective tissues, especially of the legs, breast, and abdomen. (See Pl. III.) There is rapidly advancing anemia, emaciation, and great debility, although in the large majority of cases the appetite remains good throughout, no matter how high the fever may be. There is extreme pallor of the visible mucous membranes, followed at a later period by a yellow tinge. From first to last there is a progressive wasting.

The blood at first presents a normal character, but after a varying period of time undergoes marked changes. The white corpuscles are increased in number, while the red cells usually cease to form normal rouleaus, lose their individuality, and run together, forming irregular masses which are first of a dark appearance but gradually become pale owing to the loss of coloring matter as the disease advances.

The presence of the flagellate is not continuous during the whole course of the disease. At first it is usually found in small numbers in the blood, but it increases with greater or less rapidity until, having attained a maximum, it disappears either gradually or suddenly, to

⁶ Lingard, Alfred. Report on horse surra. Bombay, 1893.

reappear after an interval. The periods during which it may be observed in the blood by microscopic examination are marked by extreme irregularity, varying from one to six days, though the latter number is very unusual.

The disease is invariably fatal in horses, death usually being due to exhaustion, but sometimes to concurrent complications. After death no specific lesion is present, but as a rule there are small subpleural, subendocardial, and subperitoneal extravasations, together with enlargement of the liver and spleen. If death takes place during a paroxysm the hematozoan will be found for a certain time in the blood. (See Lingard, 1893, pp. 1-2.) There is also an edematous exudate into the cellular tissues of the legs and abdomen, and the lymph glands are edematous and enlarged. The kidneys are congested and edematous or the seat of blood extravasation. Gastric ulcers have been noted preceded by capillary embolism and congestion.

In cattle affected with this disease the trypanosomes are frequently found in the blood before the animals show outward symptoms. (See Pl. II, fig. 2.) During this time, however, they serve as a means of spreading the disease. It is interesting to notice that in cattle the affection, unlike the affection in solipeds, is relatively benign, and many cattle, after having the disease for a time, recover. The first noticeable symptom is dullness followed by progressive emaciation with slight temperature variations. Under the breast and abdomen may be noted occasional areas of edema, accompanied by mucopurulent inflammation of the conjunctiva, cornea, and nasal mucosa. Lingard has stated that, although during the paroxysms of the disease the blood of the bovine species teems with the hematozoan, and their bodies become extremely emaciated, nevertheless the cattle usually recover from an attack and in time put on flesh and appear in robust health.^a

However, cattle seem to vary in susceptibility to the fatal effects of surra in different countries. For instance, when surra was introduced into the Island of Mauritius in 1901 by an importation of Indian cattle, 70 to 80 per cent of the native cattle, it is said, later succumbed to the disease. It must be remembered that in tropical countries the transmitting agencies are present to some extent all the year round, the disease being spread more actively during the rainy season, owing to the larger number of flies present and to the humid state of the atmosphere, which favors greater dissemination.

^a For a detailed account of surra the reader is referred to Bureau of Animal Industry Bulletin 42, or to the same article in the Eighteenth Annual Report of the Bureau, entitled "An emergency report on surra."

PROMPT ERADICATION OF THE DISEASE.

As the decision had been made to destroy only those cattle of the Borden importation which harbored the trypanosome of surra, the first step taken after the killing and burning of the three infected zebus was to protect the remaining cattle from the biting flies and mosquitoes which swarmed around the corral in countless numbers. Therefore on July 24 was commenced the flooring and screening of that portion of the corral occupied by the cattle, and this work was accomplished July 27.

While the inclosure was being screened the cattle were necessarily removed from their original positions and placed temporarily in the open along the north and west sides of the corral. On completion of the screening of the south and east sides of the corral an abundant supply of sticky and poisonous fly paper was spread about within the inclosure, and very shortly all the *Tabanus atratus* were caught or destroyed, along with large numbers of the other Tabanidæ and *Stomoxys calcitrans*, one of the Muscidæ. However, a considerable number of the latter species and a few *T. lineola* and *T. costalis* still remained, and it seemed impossible to eliminate them by this temporary screening.

The second series of inoculations was made on July 31, the results of which were anxiously awaited, as upon the outcome depended the fate of the entire herd. The hope was entertained that if the Tabanidæ were solely responsible for the spread of the infection (which dissemination was expected under the circumstances); there were prospects of saving some of these valuable animals brought at great risk and expense 10,000 miles over the seas. On the other hand, should the other species of flies, which were far more numerous and very difficult to eliminate, be found to be active disseminators of the disease, the hopes of saving even one animal would have to be abandoned. On the expiration of this test, which gave seven reactions (Nos. 48, 1, 2, 50, 34, 41, and 44), it was decided that it was possible eventually to save part of the herd by placing each animal in an individual fly-proof stall, and by eliminating the infected cattle by blood inoculations of rabbits. After this second test it seemed plausible to consider that only the Tabanidæ—and probably only the *Tabanus atratus*—were responsible for the spread of the infection, and that the disease would be eradicated with the elimination of those animals which had been infected by these flies previous to July 27, when this *Tabanus* was effectually excluded as a factor in the conveyance of the infection.

A specially constructed fly-proof stable containing individual fly-proof box stalls was therefore erected for the purpose of eliminating all kinds of flies, and especially the stable fly, *Stomoxys calcitrans*,

considered by some authorities as being capable of transmitting trypanosomal infections. This stable was completed on August 15, by working three shifts of carpenters, and during its construction the third (August 6) and fourth (August 11) tests had been made, resulting in the reaction of four animals in each test.

The appended table shows the positive results of the blood inoculations.

Positive reactions of rabbits to surra, following inoculations with blood of zebus.

Date of inoculation.	No. of animal.	Date of diagnosis.	Period of incubation.
First test, July 5 and 6.....	39	July 15	Ninth day.
	42	July 16	Tenth day.
	16	...do....	Do.
Second test, July 31.....	43	Aug. 6	Sixth day.
	1	Aug. 7	Seventh day.
	2	...do....	Do.
	50	...do....	Do.
	34	Aug. 9	Ninth day.
	41	...do....	Do.
Third test, August 6 ^a	44	...do....	Do.
	26	Aug. 11	Fifth day.
	40	Aug. 12	Sixth day.
	6	...do....	Do.
Fourth test, August 11 ^b	47	Aug. 15	Ninth day.
	45	...do....	Fourth day.
	5	Aug. 16	Fifth day.
	37	Aug. 18	Seventh day.
	7	Aug. 20	Ninth day.

^a In addition to those recorded in this test, Nos. 1, 43, and 44 repeated their reactions of the second test, while rabbit No. 50 died before trypanosomes were found. Nos 2, 34, and 41 did not repeat in the third test.

^b Besides these original reactions in the fourth test, Nos. 6, 26, and 47 of the preceding test repeated, while rabbit No. 40 died on August 22 without showing any trypanosomes. These unintentional retests occurred in the third and fourth series owing to the inoculations being made so close together that the rabbits in the preceding test had not time to react before the next series was injected.

The cattle shown to be infected with surra by these reactions in the inoculated rabbits were destroyed immediately upon the recognition of the trypanosome in the rabbits' blood. Owing to heavy rains several of the cattle were buried instead of burned, their bodies being destroyed by covering with unslaked lime and pure sulphuric acid, but in no instance was a post-mortem examination permitted, on account of the danger of disseminating the infection.

On August 15 the remaining cattle were removed from the screened corral and placed in the individual fly-proof box stalls within the fly-proof stable already mentioned. No further inoculations were made until August 31; a test made then, and subsequent inoculations made September 7, 13, and 20, and October 10, 19, and 24, proved negative in every case. On September 7 rabbit No. 48 exhibited a pseudo reaction, due, as was demonstrated later, to an intercurrent disease.

In the inoculations confirmatory tests were not made prior to August 15, owing to the danger involved in keeping the infected

cattle alive; but it was noted that several cattle—for instance Nos. 2, 34, and 41—failed to repeat in giving reactions on the subsequent unintentional retest. These retests occurred in several instances where two series of inoculations were made so close together that the rabbits in the first test had not time to react before the next series was injected.

During the quarantine no reliance was placed upon the microscopic examination of blood smears made direct from the cattle, but it will be interesting to note that in two cattle numerous trypanosomes were observed by this method of examination. As the disease spread, the average period of incubation in the rabbits was shortened, and those rabbits which were not immediately killed upon reacting soon succumbed to the infection. Guinea pigs were also used in some of the tests, but proved unsatisfactory as compared to rabbits.

In view of the fact that the last seven series of tests were successively negative, and as killing frosts had already occurred, resulting in the disappearance of all flies and mosquitoes, it was recommended that the remaining cattle, 33 in number, be released from quarantine. On November 14, 1906, the Secretary of Agriculture issued a permit to that end, and the cattle proceeded directly to their destination in Texas.

RABBIT EXPERIMENTS WITH INFECTED BLOOD.

From this importation of surra much was learned of the character of the disease and of the remarkable periodical development of the living parasite within the blood of the affected animal. Virulent blood drawn from the affected animal and injected into a test rabbit will cause a sharp elevation of temperature after a period usually varying from four to nine days, occasionally extending to ten or eleven days, but averaging seven and a half days in our experiments. If an examination of the blood of the inoculated animal is made at the time of the acme of the fever attack, numerous wriggling and squirming organisms will be seen moving about rapidly among the blood corpuscles and manifesting their presence by an active disturbance of all corpuscles with which they come in contact. If the blood is examined daily these moving hematozoa may be found present for two, three, or four days, when they suddenly disappear, while the temperature returns to normal. Now follows a latent or quiescent period lasting for five or six days, during which the temperature of the animal remains at or near the normal point, and the animal eats as usual, only showing the effects of the parasitic invasion by a staring coat and by a slight loss of flesh and energy. At the end of the latent period the same course is repeated, and again an elevation of temperature and a return of the parasites occur, only to disappear more or less suddenly at the termination of the attack. These recurring

periods of disease gradually undermine the strength and vitality of the animal until it succumbs.

Post-mortem examination of such an animal shows, first, general emaciation, together with bare denuded patches about the eyes, mouth, and nose, from which the hair has fallen. The external genitals are swollen and edematous, and more or less bare of hair. On opening the carcass it will be seen that the skin is firmly adherent to the tissues underneath; that considerable clear serous fluid has entered the peritoneal cavity; that the abdominal viscera have formed numerous fibrous attachments to the peritoneal walls; and that similar little fibers unite the various visceral organs into a more or less compact mass. The spleen will be found greatly enlarged, even to six or eight times its normal size. The liver and all of the thoracic organs will usually be found unchanged. Variously scattered over the surfaces of the abdominal walls, both internal and external, may be found small collections of the débris of degenerated red blood corpuscles, and the outer surfaces of the digestive organs within the peritoneal cavity may exhibit scattered remains of similar hemorrhages.

For experimental purposes healthy rabbits were placed in cages with rabbits that had been infected through injections of virulent blood, but no infection followed, even though they remained in close contact for thirty days, eating and drinking from the vessels used by the diseased animals.

THE RÔLE OF THE TABANIDÆ IN THE TRANSMISSION OF SURRA.

According to Lingard,^a it appears that the cattle of India, particularly plains cattle, like the camel and water buffalo, are relatively immune to the harmful or fatal effects due to trypanosomal infection, especially to *Trypanosoma evansi*. Unlike the camel and water buffalo, however, the parasites appear less frequently in the blood of Indian cattle, and sometimes at rather long intervals, accompanied by a slight rise of temperature. Practically all authorities agree that the blood of infected animals is as a rule infectious even during the incubation period. Accepting the general applicability of the above statement, the first test on July 5 and 6 shows that there existed at that time three centers of infection, and the writers are strongly inclined to believe that on arrival of the cattle on June 18 there were not more than these three infected animals in the herd. These animals may have been infected in India prior to their purchase, or on leaving Bombay, or while the vessel was moored to the dock at Kurachi from April 29 to May 5, inclusive, where a number of camel

^a Journal of Tropical Veterinary Science, Vol. 1, No. 1, April, 1906.

trains were in close proximity and *Tabanus tropicus* were present on the cattle while in port.

It is the consensus of opinion of practically all authorities on surra that the several species of flies implicated in the transmission of the various forms of trypanosomiasis act only as mechanical transmitters or accidental carriers of the infection, and that no part of the life cycle takes place in the body of the fly. A review of the literature on the subject tends to prove that all forms of these diseases in domestic animals, which are disseminated by flies (with possibly the sole exception of nagana), are spread chiefly if not entirely by some species of the Tabanidæ.

From the time the Indian cattle landed on Simonsons Island until the corral was screened several species of flies were present.^a Among these the *Tabanus atratus* deserves special mention, although the *T. lineola*, *T. costalis*, and the muscid *Stomoxys calcitrans* were also noted. The former is commonly known as the black horsefly, gadfly, or breeze fly, and is widely distributed throughout the United States. As the eggs are deposited in damp or marshy places and the larvæ are semiaquatic, the vicinity of the quarantine pen was very favorable for the presence and propagation of this species.

Tabanus atratus^b emerge as adult flies as early as May and persist until September. These large black flies were numerous and very vicious in their assaults upon the cattle, which they attacked at their most vulnerable parts, principally the hump and over the spine. As many as seven of these flies could be seen on one hump. They were most active during the late afternoon on bright days and during the entire day on dark days. The mouth parts of the female are well adapted for deep piercing, and when in the act of drawing blood they appeared to stand on their heads. When dislodged by the efforts of the animals they passed directly to the next animal, leaving, when successful, a trickling flow of blood to follow the bite. While these flies were always in evidence about the cattle up to the time of screening the corral on July 27, they were entirely excluded after that date.

The green-headed horseflies, *T. lineola* and *T. costalis*, were more numerous than *T. atratus*, but less dreaded by the cattle, and were inclined to stay upon one host, attacking any part of the body, and less frequently causing blood to flow from their bites, and then only in small quantities as compared with the *T. atratus*. These flies were not entirely eliminated from among the cattle until August 15, when the fly-proof stable was completed.

^a The determinations of the species were made by the authors.

^b For notes on the habits of this and certain other North American species of Tabanidæ see Technical Series No. 12, Part II, Bureau of Entomology, U. S. Department of Agriculture, 1906, "Habits and life histories of some flies of the family Tabanidæ," by James S. Hine.

The stable fly, *Stomoxys calcitrans*, was present in swarms, biting any part of the body, more particularly the thin skin below the knee and hock joints. They left a drop or so of blood following the bites. The swampy surroundings and decaying vegetation in close proximity to the corral furnished appropriate conditions for the rapid and numerous multiplication of these stable flies. Like the two previously mentioned species, these flies were only excluded after August 15, on the completion of the new stable.

After the second series of blood inoculations it was firmly believed that the Tabanidæ, more particularly *T. atratus*, were solely responsible for the spread of the infection, and that the disease would be eradicated with the elimination of those animals which had been infected by these flies previous to July 27, when this species was effectively excluded as a factor in the conveyance of the infection. The results of the tests of August 11, which were followed by negative results in all later tests, proved this belief to be well founded. Allowing for the period of fifteen days elapsing between July 27 (when the *T. atratus* was excluded by screening the corral) and August 11 (when the last series of injections was made which gave positive results) as the longest period for the incubation of surra in the cattle after the exposure to this *Tabanus*, and for the fact that large numbers of *S. calcitrans* and a few *T. lineola* and *T. costalis* were present in the inclosure from July 27 to August 15, a period of nineteen days, it will be admitted that the last three species played a small, if any, part in the transmission of the infection. Had these flies been capable in this instance of conveying the parasite to any extent it is evident that hardly one animal would have escaped becoming infected. Final results based on the theory that *T. atratus* was solely responsible favors the opinion that the cloth screening of the corral would have been sufficient if the presence of this *Tabanus* could have been prevented. Figure 1 shows location and total number of cattle that became infected in this interesting experiment.

The evidence herein submitted indicates that the transmission of surra in this outbreak was made possible by (1) the close proximity of the infected and exposed animals, (2) the presence of a species of the Tabanidæ, acting as an intermediary bearer, and (3) the warm and humid climate which prevailed at that time.

That the season was warm and humid during the period under discussion is borne out by the meteorological summary of the New York station of the United States Weather Bureau for the days between June 18 and July 31. During this period there were but six clear days, the maximum temperature averaging 81.6° Fahrenheit, and the relative humidity being above 80 on at least twenty-four of these days. By reason of this large number of cloudy and humid days prevalent during that time, the climatic conditions were very favorable for the activity of all species of flies, and the facility with which the trypanosomal infection could be conveyed from infected

to exposed animals without drying on the proboscis of the transmitting agent.

Fortunately, there was no spread of the infection outside of the original herd, because of the prompt screening and thorough isolation of the infected cattle, there being no other animals in the locality with the exception of one domestic cow and a calf kept on the premises. The latter, however, did not become infected, although they had grazed just outside of the corral and within 100 yards during the period from June 18 to July 20.

CONCLUSIONS.

1. In July, 1906, the first outbreak of surra in the United States was observed in an importation of zebus from India, and the disease was promptly eradicated by slaughtering and destroying the infected animals.

2. The causative agent of the disease is the protozoan *Trypanosoma evansi*, an eel-like organism which appears in the blood periodically in swarms. This parasite is transmissible from infected to healthy animals by biting flies, and possibly by other agencies.

3. Surra is a strictly infectious disease occurring in horses, cattle, sheep, and other animals, the transmission of which in this particular outbreak was dependent upon an intermediary agent, most probably a fly, the *Tabanus atratus*.

4. Contrary to some authorities, there exist in the United States, and probably in other temperate climes, species of Tabanidæ capable of transmitting trypanosomiasis, and which need not be the identical species implicated in the transmission of these diseases in countries where these infections are enzootic.

5. It has been definitely shown that in surra as well as in other trypanosomal infections microscopical examination of either stained or unstained blood films will not suffice in making a diagnosis, and that the only satisfactory results are obtained by animal, particularly rabbit, inoculations.

6. Relative to further importations into the United States of any class of susceptible animals from surra-infected countries for agricultural purposes or for menageries or zoological gardens, the experience gained in this outbreak indicates that it would be imprudent to import such possibly infected animals without testing each individual, either before or after arrival, by blood inoculations of susceptible small animals, preferably rabbits.

7. It will at once be evident that the spread of such a disease as surra over the country would quickly lead to great destruction of live stock and to great financial loss. To prevent these losses the best efforts of this Bureau have been exerted and the disease has been rigidly controlled and promptly eradicated.

36.073

658

1395C

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 170.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY;
UNIV. OF MICH.
MAY 17 1911

THE EXTRA COST OF PRODUCING CLEAN MILK.

BY

GEORGE M. WHITAKER,

*In Charge of Work Relating to Market Milk,
Dairy Division.*

[Reprinted from the Twenty-sixth Annual Report of the Bureau of Animal Industry (1909).]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

CONTENTS.

	Page.
Introduction	119
Dairy score card	120
The requirements of modern health regulations	121
The standard of production which every dairyman should reach	122
The cows	122
The stable	122
Cleanliness of milker, utensils, etc	123
Some "horrible examples" of dairies	124
Improvements involving added expense to the dairyman	124
Clean cows and sanitary stable	124
The milk room	126
Utensils, equipment, etc	126
Summary of conditions involving added expense	128
General summary	129

ILLUSTRATIONS.

	Page.
PLATE IV. Dirty barnyards, wasteful of manure, and increasing expenses of keeping cows clean	124
V. Fig. 1.—Stable with insufficient light and ventilation. Fig. 2.—A stable that is difficult and expensive to keep clean	124
VI. Fig. 1.—Sediment in bottom of bottle of milk. Fig. 2.—A milk house favorable for dirt and odors	124
VII. Fig. 1.—Milk cans exposed to dirt and flies. Fig. 2.—An inexpensive cement milk house	124
Fig. 3. Open and hooded milk pails	127

THE EXTRA COST OF PRODUCING CLEAN MILK.

By GEORGE M. WHITAKER,

In Charge of Work relating to Market Milk, Dairy Division.

INTRODUCTION.

New methods are always more or less unpopular. Every business and profession has its conservative element which looks with suspicion at new ideas, especially those which threaten to jolt one out of well-established ruts. For instance, many of the old-school surgeons were skeptical about bacteriology and the aseptic methods of operating, which are now in vogue with such wonderful results. Milk producers have the same traits of human nature as other people, and many of them have been skeptical as to the utility of the newer ideas about sanitary milk which have caused them some inconvenience and expense.

Unfortunately, the movement for cleaner milk happened to be coincident with a marked increase in the cost of production, due to feed and labor problems, and a failure to get a corresponding increase in price. The feeling of dissatisfaction with prevailing economic conditions has had a tendency to develop hostility to the latest phases of milk production.

This natural feeling of irritation has been intensified in some instances by dairy inspectors who have lacked tact and good judgment; their arbitrary bearing, their ignorance, or their lack of sympathy have done much to make the movement unpopular. In some instances, also, this feeling has been increased by persons who from various motives have misrepresented modern requirements by exaggeration, ridicule, misleading half truths, or plausible generalities.

In view of this situation there seems to be need of accurate statements as to precisely what modern sanitary milk means and what extra cost it imposes on the dairyman. In considering the added cost of production due to this agitation we make the dairy score card the basis of our discussion, because it includes in convenient tabular form practically all of the points which need to be considered. This score card is in common use and is indorsed by many leading dairy and health authorities.

The card is as follows:

DAIRY SCORE CARD.

Score for equipment..... + Score for methods..... = ...Final score.

Equipment.	Score.		Methods.	Score.	
	Perfect.	Allowed.		Perfect.	Allowed.
COWS.			COWS.		
Health.....	6	.....	Cleanliness of cows.....	8	.....
Apparently in good health..... 1			STABLES.		
If tested with tuberculin once a year and no tuberculosis is found, or if tested once in six months and all reacting animals removed... 5			Cleanliness of stables.....	6	.....
(If tested only once a year and reacting animals found and removed, 2.)			Floor..... 2		
Comfort.....	2	.....	Walls..... 1		
Bedding..... 1			Ceiling and ledges..... 1		
Temperature of stable... 1			Mangers and partitions. 1		
Food (clean and wholesome... 2			Window..... 1		
Water..... 2			Stable air at milking time... 6		
Clean and fresh..... 1			Barnyard clean and well drained..... 2		
Convenient and abundant..... 1			Removal of manure daily to field or proper pit..... 2		
STABLES.			(To 50 feet from stable, 1.)		
Location of stable..... 2			MILK ROOM.		
Well drained..... 1			Cleanliness of milk room.... 3		
Free from contaminating surroundings..... 1			UTENSILS AND MILKING.		
Construction of stable..... 4			Care and cleanliness of utensils..... 8		
Tight, sound floor and proper gutter..... 2			Thoroughly washed and sterilized in live steam for 30 minutes..... 5		
Smooth, tight walls and ceiling..... 1			(Thoroughly washed and placed over steam jet, 4; thoroughly washed and scalded with boiling water, 3; thoroughly washed, not scalded, 2.)		
Proper stall, tie, and manger..... 1			Inverted in pure air.... 3		
Light: Four sq. ft. of glass per cow..... 4			Cleanliness of milking..... 9		
(Three sq. ft. 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)			Clean, dry hands..... 3		
Ventilation: Automatic system..... 3			Udders washed and dried 6		
(Adjustable window, 1.)			(Udders cleaned with moist cloth, 4; cleaned with dry cloth at least 15 minutes before milking, 1.)		
Cubic feet of space for cow: 500 to 1,000 feet..... 3			HANDLING THE MILK.		
(Less than 500 feet, 2; less than 400 feet, 1; less than 300 feet, 0; over 1,000 feet, 0.)			Cleanliness of attendants.... 1		
UTENSILS.			Milk removed immediately from stable..... 2		
Construction and condition of utensils..... 1			Prompt cooling (cooled immediately after milking each cow)..... 2		
Water for cleaning..... 1			Efficient cooling; below 50° F. (51° to 55°, 4; 56° to 60°, 2.)		
(Clean, convenient, and abundant.)			Storage; below 50° F. (51° to 55°, 2; 56° to 60°, 1.)		
Small-top milking pail..... 3			Transportation; iced in summer..... 3		
Facilities for hot water or steam..... 1			(For jacket or wet blanket allow 2; dry blanket or covered wagon, 1.)		
(Should be in milk house, not in kitchen.)					
Milk cooler..... 1					
Clean milking suits..... 1					
MILK ROOM.					
Location of milk room..... 2					
Free from contaminating surroundings..... 1					
Convenient..... 1					
Construction of milk room..... 2					
Floor, walls, and ceiling. 1					
Light, ventilation, screens..... 1					
Total.....	40	.....	Total.....	60	.....

The different items on the score card are not requirements, but things that must be considered in the production of milk; and the producer whose dairy is inspected is rated on each item according to the relation which its condition bears to perfect conditions. An advantage of the score-card system of inspection is that its statements are made in mathematical terms rather than by the vague, indefinite words "excellent," "good," "fair," "medium," and "bad." Such words mean very little, and each one may include a wide variety of conditions. The perfect dairy would score 100, and one superlatively excellent would come very close to that, say, 97 to 99. Some dairies run by wealthy gentlemen for pleasure rather than profit, just as they indulge in yachting or automobiling, will reach a score in the nineties—possibly as high as 99. Some certified-milk dairies can be given a similar score. The better class of what may be called common dairies are usually found in the seventies, and such dairies can, as a rule, be called reasonably satisfactory from the sanitary standpoint. In other words, it is not asked or expected that anyone will reach perfection; a dairy may be rated 25 to 30 points below perfect and yet have reasonably safe and satisfactory conditions. Barring a few exceptions, modern sanitary requirements are practically met by a score of 70 or thereabouts, although it is hoped that the ambitious dairyman will strive to get into the eighties or above, and that he will find appreciative consumers who will be willing to pay an extra price for milk produced under such superior circumstances.

THE REQUIREMENTS OF MODERN HEALTH REGULATIONS.

What added burdens do modern health regulations impose on the market milk producer? The answer to this question will vary much with different individuals and different conditions. Where the latter are so bad as to be rated as low as 20 the cost of reaching a score of 70 will, of course, be more than where one can start with respectable mediocrity, represented by 50, for instance; in other words, the longer the journey the greater the expense. But it should be remembered that in the change from a score of 20 to one of 70 much of the expense should be charged to ordinary decency and not to modern ideas regarding clean milk. We presume that no one, no matter how much of a skeptic he may be concerning milk bacteriology, would openly defend a condition so bad as to deserve a rating no better than 20. In such a case only an insignificant minority not worth considering would criticise a peremptory demand for radical and even expensive changes. If the expense should prove to be beyond the means of the producer there might be sympathy for him, but no criticism of the health officer who put him out of business. Indeed, conditions below 35 are so bad as to call for and justify a peremptory order for improvement.

Scores ranging from about 35 to 60 represent conditions that demand improvement. In such cases modern official milk inspection may properly interfere, although these conditions may have been hitherto regarded as satisfactory.

Upon those milk producers who already have conditions which may be expressed by about 70 or above, the newer milk ordinances impose no additional burden. Such producers are, however, voluntarily assuming an expense which is not incurred by the slovenly producer.

THE STANDARD OF PRODUCTION WHICH EVERY DAIRYMAN SHOULD REACH.

At the outset let us consider what every milk producer ought to do as a matter of decency or as an unquestioned incident of his business. It must be recognized that a certain amount of equipment is essential. There must be healthy cows, wholesome feed, plenty of clean and fresh water, and comfortable quarters. This gives 12 points on the score card to start with.

THE COWS.

In cleanliness the cows vary widely, ranging from the neglected animal with manure-plastered flanks and udders to the cow carefully groomed every day. Grooming costs money, and is not required, though there is more reason for the daily grooming of an animal that produces human food than of one that hauls a manure spreader or garbage wagon. Custom, however, demands that a horse be kept clean, whether it performs menial tasks or hauls the carriage of some person of wealth.

To raise the score for cleanliness of cattle from zero to 6.5 or 7 requires expense for bedding, for prompt removal of manure, for daily brushing the cows when they are housed, for clipping the long hairs about the udder, and for shortening the switch of the tail if it drags in the manure. But no one would defend the manure-coated cow, and an animal should be at least half clean before the modern health officer can be charged with adding to the expense of maintaining the dairy. This partial cleaning allows 4 points, which, added to the 12 noted above, gives us 16.

THE STABLE.

A proper stable is a subject that is much misunderstood and greatly misrepresented. The stable must be so located, constructed, and maintained as to promote the health of the animals and the cleanliness of the product. Many poorly constructed stables are fairly satisfactory when kept clean, and much good milk is being produced in such places by the use of proper methods. But for the present we

will consider only light and ventilation. If the stable is poorly lighted the expense of sawing a few holes and putting in sash is so infinitesimal (except in basement stables) as to deserve no consideration. The King system of ventilation—which is the system now most prominently before the public—gives good results when properly installed. This adds to the expense, but a good substitute can be found in windows swinging in so that the fresh air is admitted at the top of the sash, over the cows' bodies. This arrangement will cause no appreciable expense. Estimating light at three-fourths of perfect and ventilation at two-thirds of perfect adds (3 plus 2) 5 points to our previous estimate of 16, giving 21 in all so far.

For cleanliness of stable and purity of stable air at milking time 12 points are allowed on the score card. The most vigorous critic of modern sanitary requirements would not defend a place so bad as to deserve no credit for cleanliness. Two whitewashings a year will add so little to the expense as to be unnoticeable at the end of the year. Feeding hay or ensilage after milking instead of before adds nothing to the expense of production, but results in better milk and may add to the score. We may safely assume that ordinary decency should call for at least half-way cleanliness—6 points, which brings the score to 27.

The daily removal of manure to a field or proper pit may add somewhat to the expense, but more than the added cost will be returned in the saving of plant food. The 2 points possible to gain here is no added burden on milk production, but an actual economy. Our hypothetical score is now 29.

CLEANLINESS OF MILKER, UTENSILS, ETC.

Clean milking suits are a bugbear in some localities and have been ridiculed as an unnecessary and faddish item of outlay. The writer found a New England dairyman who while milking wore clean, though not white, overalls and jumper. When they became somewhat soiled they were used for ordinary farm work and clean ones were taken to wear when milking. Thus clean suits were always in use when milking, with no extra expense except the time required to make the changes. This allows 1 point on the score card.

Inverting the utensils in pure air so that they may drain, dry, and be aired, without opportunity for dust to fall into them or probability of contact with flies, gives the producer 3 points and can not add a penny to the cost of production. (Frequently one sees cans and pails containing a few spoonfuls of milky water standing upright and gathering dust and flies.) Total score at present, 33.

The thorough washing of utensils even when they are not scalded gives 2 points on the score card, which should not be charged to the

added cost of production. The thorough washing of all utensils ought to be considered an unquestioned and necessary incident to milk production.

Milking with clean, dry hands costs nothing and is deemed so good dairy practice as to be given 3 points. This brings the score to 38.

At least 1 point can be secured without added expense for fairly prompt removal of milk from barn, and one more for covering the cans in transit. Promptness of cooling (2 points) is not an expense, for if the milk is cooled at all the expense is the same at one time as another.

Here, then, is a score of 42, which can be considered a natural and necessary incident of milk production, with nothing allowed as yet for construction of barn and milk room, for utensils, for cooling milk, and for cleaning the cows' udders. Nearly all producers are entitled to some credit for these items, a credit which they would regard as no added burden incident to the newer requirements.

SOME "HORRIBLE EXAMPLES" OF DAIRIES.

A score of at least 42 to 45 should therefore be the lowest rating of very ordinary dairies and a prerequisite for selling milk. Let us compare this with a few actual figures. The first scoring of the dairies supplying the District of Columbia with milk averaged 43.44; 89 were in the twenties, and 224 in the thirties. The condition of dairies supplying a southern city inspected in 1910 is shown by scores ranging from 25 to 30. An investigation of the Chicago supply showed 12 per cent of the dairies in the twenties and 35 per cent in the thirties, with an average of 40.20. The score of the dairies of a Colorado city averaged about 40, and of a New Hampshire city 35 to 40.

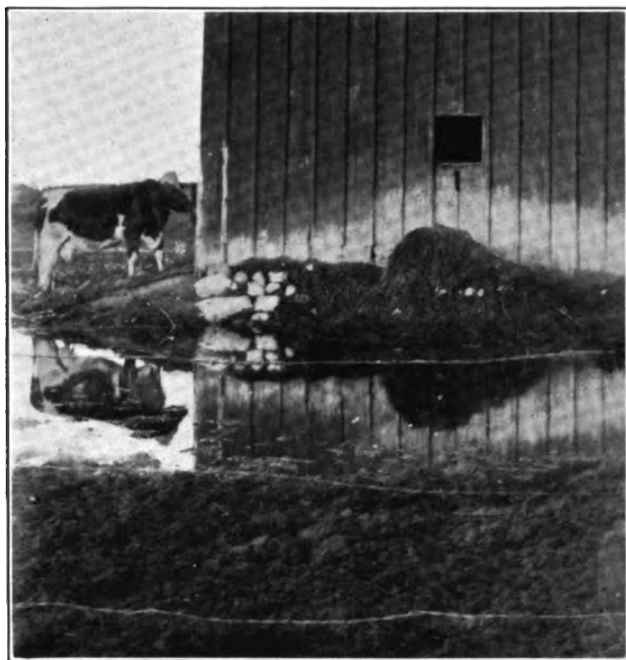
IMPROVEMENTS INVOLVING ADDED EXPENSE TO THE DAIRYMAN.

Let us now turn back to the score card to consider items passed over or receiving a low estimate, where added expense would unquestionably be incurred in effecting improvement.

CLEAN COWS AND SANITARY STABLE.

For cleanliness of cattle an allowance of 4 points was previously made—too low for a good score; five minutes per cow per day would raise the score from 4 to 7.

In regard to the stable, much criticism and misunderstanding has arisen. Some critics intimate that modern milk inspection is only a cement-floor propaganda. One newspaper writer says: "A short time since I heard a hard-working farmer say in all seriousness, 'I can't afford a sanitary barn, and if pushed shall have to go out of the milk



DIRTY BARNYARDS, WASTEFUL OF MANURE AND INCREASING EXPENSE OF KEEPING COWS CLEAN.



FIG. 1.—STABLE WITH INSUFFICIENT LIGHT AND VENTILATION.

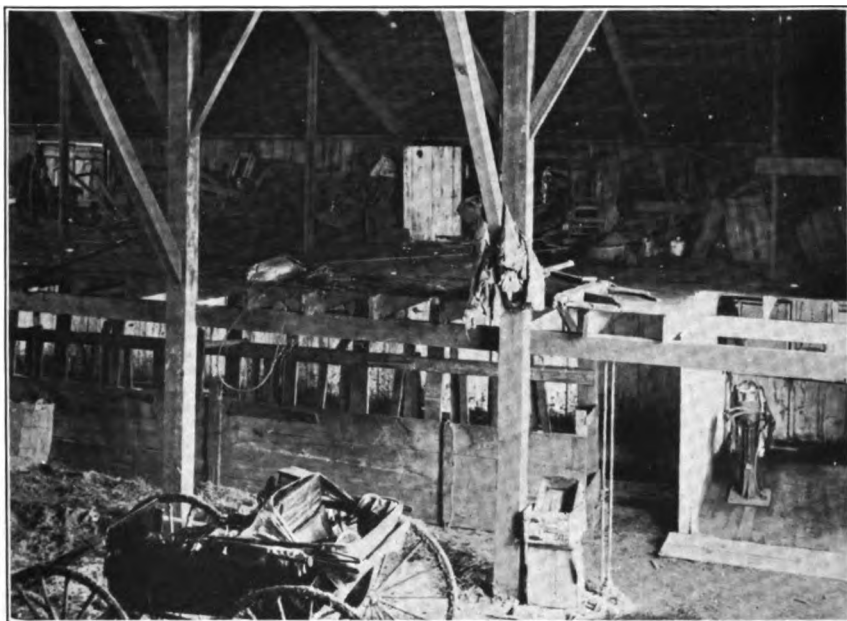


FIG. 2.—A STABLE THAT IS DIFFICULT AND EXPENSIVE TO KEEP CLEAN.



FIG. 1.—SEDIMENT IN BOTTOM OF BOTTLE OF MILK.
Such milk should not be regarded as merchantable.



FIG. 2.—A MILK HOUSE FAVORABLE FOR DIRT AND ODORS.

To find a place somewhere else for a tool and paint room and for storage would not involve great expense.

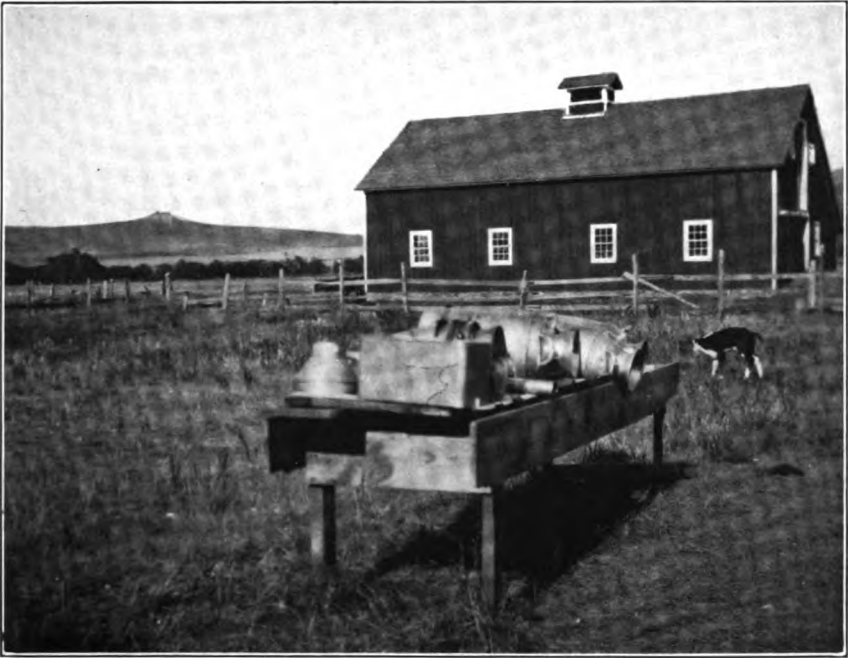


FIG. 1.—MILK CANS EXPOSED TO DIRT AND FLIES.

It costs nothing to invert cans so that dirt will not settle in them and to keep out flies. This dairy loses 3 points for improper care of cans.



FIG. 2.—AN INEXPENSIVE CEMENT MILK HOUSE.

This house is not wholly completed. Observe milk cans inverted to dry.

business.'” Says another writer: “In most cases more depends on the individual than upon the score of the barn.” His statement is literally true, though liable to be misleading. The object of good barn conditions is not merely to get a creditable score simply for the score's sake, but to help the individual in his efforts to produce clean milk and to have a healthy herd. A man who is exceptionally painstaking in his methods can get a good total score even when allowed nothing for the barn, but its poor condition would be a handicap and would increase the cost of cleanliness and caring for the herd. In this case a better barn would be an economy.

To secure a properly drained site where the country is level and the buildings already constructed may require expensive grading and other changes, but this counts only 1 point, and in such cases it may be well to see if the expenditure can not be laid out more profitably in other directions. When the site of a barn is poorly drained a clean, well-drained yard is almost impossible, and will doubtless require some expense for cement or cinders, but the result will reduce the expense of keeping the cattle clean.

To secure freedom from contaminating surroundings will frequently add nothing to the expense account, though sometimes it may mean a new place for the swine so that the incident odors and flies may not injure the milk.

A tight and sound floor, smooth and tight walls and ceiling, a wide and deep gutter, a stanchion of the “swing” type simply supported, a simple partition for stalls, and a manger which is merely a concave depression in a cement floor, are recommended as a perfect form of stable construction, carrying 4 points. These recommendations are based on the fact that a stable so constructed has a minimum of dirt-catching possibilities, and saves labor if one is to produce clean milk. Still, as has been stated, a good total score can be made by extra care when the equipment is inferior. But when the floor becomes rotten and urine-saturated, nothing can be done except to incur the expense of a new floor, preferably of cement. To offset this a tight floor will frequently pay a liberal profit on the investment in the saving of fertilizer, and hence be no burden on the producer.

A well-drained site for the barn, free from contaminating surroundings, with enough space for the cows, and proper floor, walls, ceiling, stanchions, etc., counts 9 points. But proper conditions in these respects will also help the score under the heading of cleanliness. A location poorly drained will usually have a dirty barnyard (2 points), which may be so bad as to contaminate the stable air, causing the loss of a point or two more; and this may also mean dirty cows. A rotten, soaked floor may be so filthy as to cause the loss of 2 points for cleanliness of floor and 2 more for stable air. Contaminating surroundings, such as pig pens or horses, may pollute

the stable air, causing a loss of several points. Expense in rectifying these troubles may be necessary to get satisfactory conditions, but will help both the barn score and the score for methods.

As regards cleanliness of stable and air, we have already assumed that half-good conditions should be charged to the mere fact of doing business. In some cases there will be slight expense for changes, so that horses may not be kept in the same room with the cows. With a stable so built as to facilitate economy of labor, three-quarters of an hour a day will accomplish much in cleaning up and keeping clean. This is an average of three minutes for each cow in a 15-cow dairy. An average of even two minutes more a cow—thirty minutes a day—will keep the milk house reasonably clean.

THE MILK ROOM.

In the matter of the milk room some expense may be necessary. It has been the practice at some dairies where milk is sold by the can to have no milk room or milk house. The milk is strained from pail to carrier can in the barn and allowed to stand there in winter until the time to take it to the railroad station. In summer the can is set in the tank of water in the barnyard. The dairy utensils are washed with the domestic utensils in the kitchen. Where such a condition exists there will necessarily be expense for constructing a milk house. It need not be costly. Circular No. 158 of this Bureau gives plans for such a building, to cost from \$200 to \$400. The writer found a small cement milk house in Kansas which had cost the proprietor only \$50 for material, the labor having been performed by himself.

A milk room or milk house should have smooth and tight floor, walls, and ceilings, with ample light and ventilation, and be thoroughly screened against flies and other insects. It should be used only for milk purposes and in no case for storage, especially of clothing, horse blankets, harness, or anything of such nature. The expense of the best modern practice, so far as the milk house goes, will be very slight outside of the necessities of the construction of the building itself. Four points are allowed for construction and 3 for cleanliness.

UTENSILS, EQUIPMENT, ETC.

The score card calls for facilities for washing and sterilizing the utensils in the milk house itself, not in the kitchen, and the practice of bringing hot water from the kitchen stove is not satisfactory. In some instances there must be an expense of from \$10 to \$50 for a heater to furnish the necessary hot water or steam.

A small-top milk pail will cost from \$1.50 to \$2, according to the pattern used; in some places a small-top cover for ordinary milk

pails can be secured as low as 75 cents. If three or four pails are used, the added expense will range from \$3 to \$12.

A milk cooler is desirable for the best work, and will cost in the neighborhood of \$15, though where milk is sold by the can, fairly satisfactory results are obtained by setting the cans in a tank of cold water.

The added expense to each producer for new construction and equipment can not be estimated on account of varying conditions. In many cases it will be nothing, and in others it may vary from 75 cents for a small-top pail cover to \$2,000 or even more for a new stable and milk house. Where the barn is old and in bad condition,

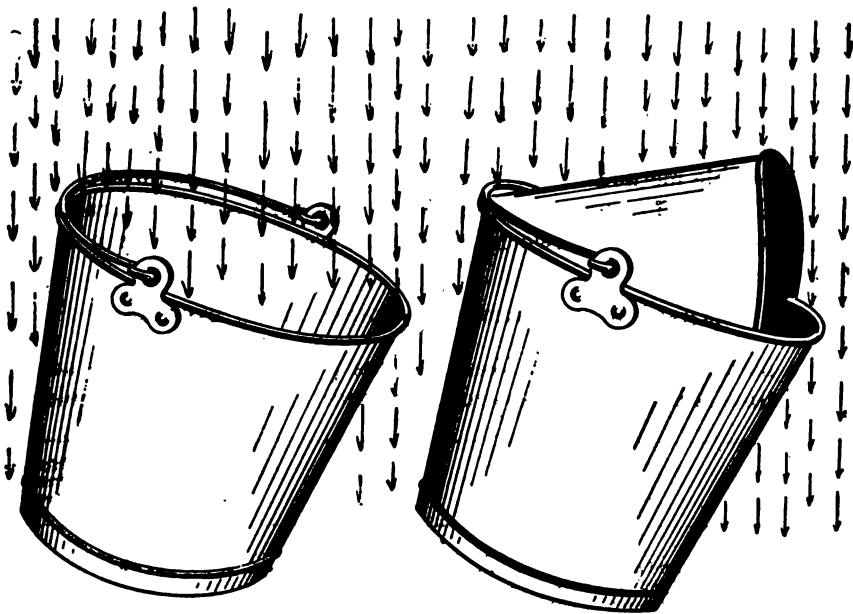


FIG. 3.—Open and hooded milk pails. A hooded pail will keep much dirt out of the milk. The hood can be put on by any competent tinsmith for a small price.

but well located, to make repairs upon it may be extravagance. To let it stand to be used for storage and to build a one-story cow stable as a wing may be advisable. If we assume the extreme of \$2,000 on construction account, 10 per cent a year for depreciation and 5 per cent a year for interest on investment will make an annual expense of \$300. This is \$20 per cow per year in a 15-cow dairy, and less where more are kept. The number of farmers who ought to make a \$2,000 investment is comparatively small; for the average producer this figure would be excessive.

The cost of scalding utensils is chiefly caused by the investment for a heating apparatus. There may be a little additional expense for fuel. Scalding the utensils will add 2 points to the score already

allowed, and will frequently cause a saving in losses from sour milk.

Wiping the udders with a dry cloth a few minutes before milking gives 1 point. Many producers waste time here. After sitting down to milk they wipe the udders with a dry cloth or with bare hands, raising a dust which settles into the milk and increases the contamination. Time has been wasted and the product is worse for the misdirected energy. The udders should be wiped long enough before milking to allow dust to settle. Wiping the udders with a moist cloth gives 4 points, while the added trouble of washing and drying the udders adds 2 points more. Two minutes per cow will gain the 4 points.

Two points are allowed for removing the milk immediately from the stable as fast as each cow is milked. There is no excuse for allowing milk to stand in the stable, absorbing odors, until all the milking is done, and 1 point has already been allowed for part-way commendable methods. To remove the milk of each cow in the milking pail to a milk house or milk room may take a little extra time. Estimate this labor at two minutes per day per cow to gain the 1 point.

SUMMARY OF CONDITIONS INVOLVING ADDED EXPENSE.

We have now assumed fifteen minutes per cow daily as the additional time necessary to raise ordinary conditions, 16 points, as below:

Item.	Minutes per day per animal.	Additional points gained.
Cleanliness of cows.....	5	8
Cleanliness of stable and air.....	8	4
Cleanliness of milk house.....	2	2
Scalding utensils.....	1	2
Wiping udders.....	2	4
Removal of milk.....	2	1
Total.....	15	16

We have assumed in the first part of this article that any dairyman should secure at least 42 points as the lowest score that could be considered as a necessary incident of doing business, and none of the expense of reaching this standing should be charged to the advanced teaching of modern bacteriology. A dairyman really ought to do much better than that before anything is said about the added burden of meeting up-to-date sanitary requirements. But let the figure stand at 42 for the sake of moderation and conservatism. We have now shown how an expenditure of fifteen minutes per day per cow in a 15-cow dairy will add 16 points to the score, bringing it up to 58. Estimating labor at 20 cents an hour, 5 cents a day per cow, in addition to the expense of ordinary conditions, will give a rating

of 58. This includes nothing for cooling and storing milk and nothing for stable and milk room.

Milk must be cooled to 50° F. or below to secure a perfect score for efficient cooling, and when evening's milk is held for morning delivery it must be held at the same temperature to score perfect for storage. These 8 points, and 2 more for perfection in transportation, necessitate the use of ice. Spring water which would cool the milk below 60° F. would raise the score from 58 to 61, and would in most cases add nothing to the cost of production.

Should the use of ice be charged against the expense of modern bacteriology? In some parts of the South dairymen who retail their own product and have not been accustomed to use ice make two deliveries a day. Under such conditions the use of ice for the efficient cooling and proper storage of milk would be an economy instead of an added expense, for ice would be less expensive than the second delivery. In New England, New York, and some other States ice is regularly stored by the farmers and is regarded as necessary as the hay crop. In those States the use of ice adds nothing to existing expenses. It seems to the writer hardly reasonable to include the expense of ice in the "burden" of up-to-date milk production; but compromising on this by considering cooling to and storing at 55° F., which carry 6 points instead of 8, and the score is raised from 58 to 64. This has caused an added expense of 5 cents per cow per day, with as yet no allowance or estimate for construction of stable and milk house, small-top pails, cooler, etc., which give 18 points in all. If a producer gets one-third of this, or 6, his total score will be 64 plus 6, or 70. The added expense of these 6 points will vary from nothing to the extreme expense of about 5½ cents per cow per day in a herd of 15 for new construction, repairs, and equipment.

One other item of added expense has never been noticed in the discussion of this subject. In the production of reasonably clean milk constant care is required—eternal vigilance is needed. It is only reasonable that the dairyman should have some compensation for this. As his product improves he is more and more of a careful, skilled workman, and he should therefore be better remunerated. There may be a wide variation of opinion as to the amount of this added compensation, but for the purpose of making an estimate we will place it at 5 cents per cow per day in a herd of 15.

GENERAL SUMMARY.

To sum up: To increase the score of a dairy from 42 to approximately 70 points there may be in 15-cow dairies an added expense of 5 cents per cow per day for labor, plus, in extreme cases, 5½ cents for new or additional equipment; and if we add 5 cents more to remunerate the proprietor for his extra care and vigilance there will be an extreme

increase of $15\frac{1}{2}$ cents per cow per day. The product of a cow ranges from 4,000 to 10,000 pounds of milk a year, or from 5 to 12 quarts a day. The added expense for labor would therefore amount to about half a cent to 1 cent a quart, and in the rare instances where great additional expense is required for repairs, new construction, and new equipment, this might raise the increase 1 to 2 cents a quart more. The allowance for extra remuneration to the dairyman for added care, which is usually not included in estimates of this kind, but which is considered in the business world in estimating what is reasonable as to salaries, would bring the total added expense per quart from $1\frac{1}{2}$ cents when cows give large amounts of milk to 3 cents when the cows are of low production. The added actual labor and the remuneration for the proprietor—without any new construction or equipment—would increase the expense from 1 to 2 cents a quart. This added expense of improved methods and equipment, however, would no doubt be partly offset by increased production and increased economy of feed, so that the net extra expense of producing clean milk would probably be somewhat less than the figures given.

The writer has made no attempt to discuss, in a dogmatic way, the added expense of producing sanitary milk, but rather to offset the exaggerations and vague generalities which have been published about oppressive and unreasonable demands by specific statements concerning the various details of the dairy industry. In other words, the purpose of this paper is to show that while modern sanitary requirements are not as burdensome as has been represented in some quarters, yet high-grade milk does necessarily cost more than a mediocre product. We have not discussed the difference in actual cost between dirty and reasonably clean milk; that question, indeed, admits of no discussion. Dirty milk ought not to be considered a merchantable article at any price, no matter how low. Any mention of cost or selling price ought to presuppose milk that is at least half-way clean—say, such as would be produced in a dairy scoring in the vicinity of 50.

The fact that there have been exaggerations of the demands and added expense of modern inspection is no argument against the consumer recognizing that the word "quality" as applied to milk means more than chemical composition, that there may be milks of widely varying quality even where the amount of milk solids is the same. A reasonably clean milk is worth 2 cents more than common slovenly milk. The former is safer and therefore cheaper at the increased price.

There has been too much indifference on the part of consumers regarding clean milk, too much of a tendency to regard all milk as the same, and too much of a desire to buy it at a low price, regardless of quality. Merely as a matter of sentiment and refinement, clean and

fresh fruit and vegetables command a premium, while dirty food is frequently unsalable at any price. Milk, however, is often regarded with less discrimination. A little sediment meets with no emphatic disapproval. Consumers on seeing side-by-side pictures of bad and of sanitary stables comment favorably on the latter and express disapproval of a food produced in the former, but they haggle over the price and when it comes to paying the bills fail to recognize more value in one kind of milk than the other. Milk in most instances is consumed raw, and is exposed to the direct contamination of all the bad conditions with which it comes in contact. Furthermore, it is the exclusive diet of many invalids and infants, and is an almost perfect medium for the development and spread of germ diseases. Aside from any refined prejudices in favor of clean food, dirty milk may prove expensive even as a gift, while clean milk may be an economy at several cents above the ordinary price. The cheapest article is often the most extravagant. A few additional cents a quart for milk is cheap insurance against some forms of sickness. At the higher price the food material in the milk is cheaper than in many kinds of meat.

The propaganda for the production of cleaner milk must be accompanied by an educational campaign among consumers for a realization of the superior safety of the better article and an appreciation of its greater value, expressed in dollars and cents.



3 6.073
158
1295c
U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 171.
A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY;
UNIV. OF MICH.

JUN 18 1911

FERMENTED MILKS.

BY

L. A. ROGERS,

*Bacteriologist in Charge of Research Laboratories,
Dairy Division.*

[Reprinted from the Twenty-sixth Annual Report of the Bureau of Animal Industry (1909).]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

CONTENTS.

	Page.
Introduction	133
Food value of fermented milk	134
Therapeutic value of fermented milk	134
The various forms of fermented milk	141
Cultures in tablet and capsule form	141
Buttermilk	142
Kefir	147
Kumiss	151
Yoghurt, etc	153
Bibliography	156

ILLUSTRATION.

	Page.
FIG. 4.—Organisms causing fermentation of milk	142

FERMENTED MILKS.

By L. A. ROGERS,

Bacteriologist in charge of Research Laboratories, Dairy Division.

INTRODUCTION.

Within recent years there has been a rapidly growing interest in the therapeutic value of buttermilk and other fermented milks, such as kefir, kumiss, and yoghurt. This is seen in the increasing sale of buttermilk, in the large number of special preparations now offered for sale, and in the frequent discussion of this subject in popular and scientific publications. Buttermilk is not only consumed in large quantities as a beverage, but is recommended by physicians as a therapeutic agent in the treatment of intestinal disorders, and is in constant use in many hospitals.

It is the aim of this paper to give the reader a brief résumé of our present knowledge of this subject. The literature relating to fermented milks is already voluminous, and few persons, not even physicians, are so situated that this can be brought together and assimilated. It will be necessary for the benefit of those having a professional interest in the subject to include information of a somewhat technical nature.

All of the more familiar fermented milks are the result of an acid fermentation in which the sugar of the milk is split up into lactic acid. This may be brought about by the presence in the milk of varieties of the common lactic-acid group of bacteria, or, as in the case of yoghurt, by special organisms; or a yeast may be present, adding an alcoholic to the ordinary acid fermentation.

In many large cities special fermented milk preparations can be obtained under various trade names—zoulak, vitallac, yoghurt, matzoon, bacillac, kefir, kumiss, and lacto-bacilline. These are all soured milks which have been introduced from southern Russia, Turkey, and neighboring countries. They are sold as freshly prepared milk, or in the form of tablets or powders in capsules which may be taken directly or used to ferment milk. These preparations have been widely advertised and are the subject of very positive statements in regard to the benefits derived from their use.

Before discussing the various types of fermented milk it will be well to consider briefly the claims made for fermented milks in general, and the actual information on which such assertions are based.

FOOD VALUE OF FERMENTED MILK.

The high food value of milk is too generally recognized to need discussion here; fermented milks also have a high food value, except that in some cases the fat is partially or entirely removed. Otherwise the food value of the fermented milk differs little from that of the fresh milk from which it is made. Any increased digestibility of the fermented milk is due not so much to change in the chemical nature as to the fact that the casein is furnished in a precipitated and finely divided condition. In none of the fermented milks is there any material cleavage of the casein resembling the digestion in the stomach. The fat is almost unchanged, and a part only of the sugar is converted into acid, alcohol, or gas. In certain gastric troubles in which it is difficult to find any food that can be retained by the patient, fermented milks are frequently used with good results. Kefir and kumiss especially are used under such circumstances, as the stimulating action of the carbon dioxide which they contain is believed to aid in their digestion. The value to the physician of a highly nutritious food which can be digested when other foods are rejected is obvious.

THERAPEUTIC VALUE OF FERMENTED MILK.

Fermented milks have been used since very early times, and it is probable that their value in treating intestinal disorders has been known in an indefinite way for centuries, but it is only in recent years that their therapeutic possibilities have been recognized by physicians. The development of bacteriology was necessary to supply the information on which the rational use of this therapeutic agent is based. For the past fifteen or twenty years medical journals have contained occasional papers on fermented milks of various kinds, and at one time the use of kumiss in the treatment of tuberculosis and other diseases was much discussed. The present interest in the subject is largely due to the work of Metchnikoff and his students.

Metchnikoff's views are set forth in a popular way in Chapter V, "Lactic acid as inhibiting intestinal putrefactions," of his book entitled "The Prolongation of Life."⁵⁴ He relates many marvelous incidents as to the therapeutic and prophylactic value of fermented milk. The narrative of the sailor who was cared for by Arabs who sometimes reached the advanced age of 200 or 300 years on a diet of soured camel's milk is admittedly somewhat exaggerated, but many cases are cited of exceptional longevity presumably through the use of fermented milks. It should be remembered that the peoples who habitually use fermented milks are hardy races living and working in the open air, and while their good health may be due in

^a Figures refer to bibliography at end of paper.

part to their simple milk diet, it by no means proves that sour milk is the elixir of life as some writers would have us believe.

Fermented milks are now recommended when a nutritious and digestible food is essential, but it is in the treatment of disorders resulting from autointoxication that their chief value is supposed to lie. Auto-intoxication may be caused by the undue accumulation of poisonous substances which are promptly removed in health. Toxic substances usually found in small quantities may be produced in excess, or, what is more common, toxins may be formed by bacteria in the intestines in amounts too great to be disposed of through the usual channels. These toxic substances are absorbed into the system and produce symptoms which may be merely an uncomfortable feeling of indigestion and headache, or which may assume the more acute form frequently and erroneously spoken of as ptomaine poisoning. This form of autointoxication is usually accompanied by intestinal gas and foul-smelling stools. One symptom of great value to the physician is the excretion in the urine of abnormal quantities of indican and ethereal sulphates.

The phase of autointoxication which the advocates of the use of fermented milk hope to reach is caused by the decomposition of the partly digested food by bacteria. The digestive tract of the human being is normally free from bacteria at birth. In a short time, however, bacteria gain an entrance, and from that time the intestines are never free from micro-organisms. If an infant is breast fed the variety of bacteria is limited, but if it receives cow's milk the number increases more rapidly and the variety is correspondingly greater. Many persons have erroneous ideas in regard to the contamination of foods by bacteria, and statements are sometimes made which have no basis in fact. It is true, however, that any food may act as a carrier of bacteria, although in properly prepared food the number is usually small. There are some exceptions, as, for instance, milk, and there is no difficulty in explaining the presence of bacteria in the digestive tract. The acidity of the stomach is so high and the food is retained so short a time that under normal conditions bacteria do not multiply appreciably there, but are carried into the intestines, where conditions of temperature, chemical reaction, and nutriment are favorable to the rapid development of many kinds of bacteria. Certain kinds of bacteria establish themselves in the intestines, especially in the lower or large intestine, and are found so constantly there that they may be considered as normal inhabitants of the digestive tract. Among those most familiar to bacteriologists are the *Bacillus coli communis* and members of the *Bacterium aerogenes* group. Other varieties may be present constantly or may appear for a short time only, this depending largely on the nature of the food consumed. Most of the bacteria occurring in the intestines are prob-

ably harmless, at least under ordinary conditions. It is not improbable that some of them aid digestion in some way, and may be looked upon as beneficial. On the other hand, unusual varieties may appear, or varieties normally present may be influenced by unusual circumstances to produce changes detrimental to their host. Our knowledge of the bacteriology of the intestines is not yet sufficient to connect intestinal autointoxication with any particular species or group of bacteria, but recent work has indicated that while the normal bacteria of the intestines are of the class growing equally well in the presence or absence of air, autointoxication is coincident with the appearance in the intestines of bacteria growing only under conditions that exclude air. *Bacillus aerogenes capsulatus* is a typical member of this group.

It is not advisable in this paper to consider in any detail the chemical changes that result in the production of toxic substances. It is sufficient to note that it is not necessary to assume the presence of any specific toxin in the ordinary sense of the word. Many products of metabolism which are harmless in small amounts become toxic in excess. The carbohydrates of the partly digested food may be broken up by bacteria into gases, alcohols, and organic acids which are irritating to the delicate mucous membrane. From the proteins may be formed products toxic in their nature. The work of Vaughan and his associates shows that certain of the normal products of digestion may under some combinations of circumstances be split into two substances, one of which is harmless while the other is highly poisonous. Thus slight changes in the course of the decomposition which food undergoes in the intestine may have far-reaching effects on the system.

The use of fermented milk in combating autointoxication is based on the theory that the introduction of lactic-acid bacteria produces conditions unfavorable to the growth of the toxin-producing bacteria. The inhibiting action is believed to be due partly to the acid formed in the milk before it is ingested and partly to the introduction into the digestive system of large numbers of lactic-acid bacteria which become established there and tend to suppress the activities of the bacteria which produce undesirable decompositions.

Turning to the scientific demonstration of the value of sour-milk therapy, we find that most of the evidence is clinical, based on the observation by physicians of the effect of sour milk in various pathological conditions. Numerous instances could be cited of marked improvement of intestinal troubles following the use of sour milk. As has been noted, this action may be due—

(a) To the action of the lactic acid contained in the milk at the time it is taken in inhibiting the activities of undesirable bacteria in the digestive tract;

(b) To the growth in the intestines of the bacteria taken with the milk which suppress other forms either by the acid produced or through means not identified with acid formation.

Considering the possible action of the acid of the milk in suppressing undesirable bacterial fermentations, we find that it is well known that the growth of some bacteria can be prevented by acids and that different species of bacteria show marked differences in their tolerance to an acid reaction. Many bacteria fail to grow in a medium only slightly acid. As milk sours the many varieties of bacteria usually present in the fresh milk are eliminated one by one until in the curdled milk one or two forms only are found in appreciable numbers. Some peculiar species, as the vinegar organism, are able to stand comparatively high acidity, but these are exceptional, and vinegar is sometimes used as a preservative, especially in the manufacture of many kinds of pickles. The intestinal flora, however, always includes some bacteria capable of growing in a distinctly acid medium. Moro⁵⁷ isolated from the stools of breast-fed infants a bacillus able to grow in whey acidified to 0.9 per cent. *Bacillus coli communis* and members of the aerogenes group, which are almost invariably found in the digestive tract, thrive in a moderately acid medium. These two groups ferment sugars, forming organic acids, large quantities of gas, and sometimes small amounts of alcohol. The ingestion of soured milk would be very unlikely to overcome the natural alkalinity of the intestines sufficiently to inhibit bacteria of this class. Moreover, an increase in the milk used would increase the supply of sugar from which gases could be formed. This condition would be exaggerated by the practice frequently recommended of adding to the diet foods rich in sugar to furnish food for the lactic-acid bacteria.

An acid condition of the intestines is carefully guarded against by the provision for the neutralization of the acid juices of the stomach as they enter the intestine. It is probable that this action is largely automatic and that an increased acidity in the food coming into the intestine would be followed by a corresponding increased flow of alkaline secretion. If it were possible to render the contents of the intestines so acid that bacterial growth would be checked even slightly, the action of the digestive enzymes of this region would be almost or completely stopped and serious consequences would result. It is possible that the intestines may contain bacteria whose growth could be checked by a decrease in the alkaline reaction. There is some clinical evidence favoring the use of lactic acid in cases of intestinal autointoxication, but this is not very conclusive. It seems improbable that the acid contained in any form of fermented milk would be great enough to affect the activities of intestinal bacteria.

However, the efficacy of fermented milk is supposed to depend mainly not on the acid contained in the milk, but on the heavy inoculation of acid-forming bacteria into the intestines and their continued growth there to the exclusion of other forms. The evidence that such a condition can be induced is not altogether conclusive. The advocates of the use of sour milk have used for the most part in their experimental work a peculiar bacterium which forms an exceptionally high percentage of acid and which is said to be particularly adapted to acclimatization in the intestines. This micro-organism is generally known as the Metchnikoff bacillus, the bacillus of Massol, or *Bacillus bulgaricus* (see fig. 4, a). Cohendy,¹² who fed four patients for extended periods on milk curdled with *B. bulgaricus*, concluded that this organism became readily established in the intestine and that it persisted there for a considerable time after the subject had ceased to take fermented milk. This was said to be especially true if a diet were adopted containing suitable nourishment for the ingested organism. It is stated that the multiplication of these bacteria took place in the upper two-thirds of the colon. The stools were acid or neutral. The same writer in another paper¹⁴ shows that intestinal putrefaction as indicated by the excretion of ethereal sulphates in the urine was materially reduced by the addition of a sour milk to the diet, and that this reduction, which may reasonably be attributed to a disinfection of the large intestine, continued after the ingestion of sour milk was discontinued. This may be taken as an indication that the growth of the bacteria continued after their introduction ceased. This disinfecting action of the lactic-acid culture was not appreciably influenced by variations in the amount of sugar eaten, indicating that the ordinary diet contains sufficient sugar to support the growth in the intestines of the lactic bacteria.

Belonovsky³ studied the effect of the *Bacillus bulgaricus* on the intestinal flora of mice. In his experiment several lots of mice were fed on a basic ration of sterilized grain and water, and to the ration of two of these lots were added milk cultures of the *B. bulgaricus*. Mice fed on this ration one and one-half months showed this organism in the droppings fifteen days after the last feeding; with animals fed the culture for four months it was present for four weeks after the last feeding.

On the other hand, Herter³⁹ found that in the digestive tract of a monkey killed after feeding for two weeks on milk soured with *B. bulgaricus* this organism was abundant in the upper part of the small intestine only. In the lower part of the small intestine and in the large intestine *B. bulgaricus* was present in only moderate numbers as compared with other bacteria.

Heinemann and Hefferan³⁴ found an organism answering to the description of *B. bulgaricus* in ordinary milk, in feces of cows, horses,

and man, and in soil, grains, and pickles. They consider that it is normally present in small numbers in the digestive tract and even suggest that it may cause pathological conditions under certain circumstances. The inference may be drawn from their work that since this organism is so widely distributed it must be taken into the digestive system almost continuously, and if it were adapted to growth in the intestines it would become established there in the natural course of events. The small amount of acid formed by their cultures in milk at 37° C. (98.6° F.) shows that they were much less active than the cultures used in making fermented milks. The most active of their cultures formed in three days only a little more than 1 per cent of lactic acid. A typical culture forms in this time at 37° C. nearly or quite 3 per cent.

It must be admitted that up to the present time the investigations have not conclusively demonstrated that it is possible to establish the lactic-acid bacteria in the intestines with any permanency.

From the cases cited or from the numerous clinical observations in which distinct benefit has resulted from the use of fermented milk it does not seem necessary to assume that the multiplication of this class of bacteria in the intestine is essential to the success of this treatment. It is very well known that bacteria excrete substances having a retarding influence on the growth of other bacteria and that in some cases at least this result is not due to acids. It is possible to explain the disinfecting action of fermented milk by assuming the existence of substances of this kind which are formed in the milk and introduced into the digestive system in amounts sufficient to have an appreciable effect on the bacteria of the intestines.

Belonovsky in the work already cited found that while there was no reduction in the intestinal bacteria in mice fed with sterilized milk or with sterilized milk curdled with lactic acid, the two lots fed milk cultures of *B. bulgaricus* showed a distinct reduction in the number of bacteria in the droppings. This was also true of the lot fed with similar cultures sterilized by heat. The diminution was especially evident in the bacteria forming gas and bringing about putrefactive changes. The evidence of the bacterial examination of the stools was confirmed by the changes in weight of the animals while under experimentation. In the two check lots receiving sterilized grain and water, in the lot receiving milk soured with acid, and in that fed sterile milk there were losses in weight; in the two lots fed with milk culture there was a decided gain; and in the lot receiving the sterile culture there was no change in weight. These observations would indicate, although they by no means prove, that the disinfecting effect is due not to the lactic acid, but to the presence in the fermented milk of some by-product having an antiseptic action on certain kinds of bacteria.

The conclusion of Belonovsky that products other than lactic acid play an important rôle are in accordance with the numerous clinical observations of North.⁴¹ His paper on this subject covers observations on many cases of rhinitis, ethmoiditis, and other pathological conditions involving the formation of pus, which were treated with cultures of *B. bulgaricus* used as a spray or wash. In a high percentage of cases this treatment resulted in improvement and frequently in a complete cure. While this work was not controlled by checks to determine the part played by lactic acid or other factors, it is much easier to explain effects of this kind on the basis of a specific antiseptic body than by attributing it to the action of a dilute acid. Conradi and Kurpjuweit¹⁶ have demonstrated that bacteria of the *Bacillus coli* group excrete substances which are antiseptic not only to other bacteria but, when they accumulate in sufficient quantities, to the bacteria secreting them. It is very probable that this is also true of lactic-acid bacteria. It should be stated, however, that the work of Conradi and Kurpjuweit has not been accepted as entirely correct. Kern⁴³ claims to have separated from cultures of *B. bulgaricus* a substance having a distinct inhibiting action on *B. coli communis*.

While there is no doubt that the benefits to be derived from the use of fermented milk have been greatly exaggerated, especially by those financially interested in an increased use of these preparations, there can be no question that in some cases, at least, much good has resulted from their use. To whatever action of the milk this effect is due, there is abundant evidence to show that putrefactive changes in the colon, with their accompanying symptoms, have in many cases been checked by the addition to the diet of some form of soured milk. Herter³⁸ found that an increase of ethereal sulphates and indican followed the ingestion with the food of cultures of the colon bacillus and *B. proteus vulgaris*. These indicators of intestinal putrefaction were diminished by a diet of bread and milk, and cultures of lactic-acid bacteria usually produced a marked decrease. Results of a similar nature have been obtained by others, notably by the associates of Metchnikoff. To this could be added many observations by physicians cited in the medical journals.

It is probable that in many cases an improvement in health following the use of fermented milk may be due not so much to the action of the acid-forming bacteria as to a marked change in the dietary incidental to the use of the milk. Herter and Kendall^{40a} found that the nature of the bacterial flora of the intestines could be promptly and distinctly changed by a radical change from a diet high in protein to one in which carbohydrates predominated, or vice versa. A high protein diet caused symptoms of intestinal putrefaction. A change to a carbohydrate diet resulted in a reduction of the putrefac-

tive bacteria, an increase in the acid-forming bacteria, and the disappearance of the indications of autointoxication.

There are many questions that should be very carefully considered before a fermented milk is introduced as an important part of one's diet. As Herter³⁹ has pointed out in the admirable paper already cited, the addition of fermented milk to the diet may change very materially the ratio of protein to other classes of food. If the milk is taken in place of other food, the daily protein ration may be so reduced that intestinal putrefaction, which is dependent on the protein part of the food, is diminished. On the other hand, if milk is added to the usual food, the protein ratio will be increased rather than diminished. In many cases the condition of the mucous membranes will not permit the presence of organic acid, and soured milk can not be retained. It is also possible that symptoms of autointoxication are due not to unusual bacterial activity in the intestine, but to functional failure of certain organs. This point could be determined only by a physician. It would be very unsafe to consume large quantities of milk, fermented or unfermented, under certain pathological conditions. In any case an important change in one's diet should be made only upon the advice of a physician.

THE VARIOUS FORMS OF FERMENTED MILK.

If it is considered advisable to use cultures of acid-forming bacteria, the form in which these are taken becomes an important question. In large cities one usually has a choice of lactic-acid bacteria from several sources. Buttermilk is usually available, although it is not always of good quality. Sometimes kumiss or kefir can be obtained, and at the present time milk coagulated with the so-called Metchnikoff bacillus is sold as yoghurt or matzoon and under various trade names.

CULTURES IN TABLET AND CAPSULE FORM.

In addition to these freshly prepared preparations several tablets or capsules purporting to be pure and active cultures of the *Bacillus bulgaricus* are now offered for sale. These are for use in fermenting milk or are to be taken directly in place of buttermilk or yoghurt. Herschell³⁷ in his little book on the therapeutic uses of soured milks recommends the use of these preparations in preference to fermented milk, but it should be noted that he is very explicit in his statement that great care should be taken to determine the abundance and purity of the desired organism. Three brands of these tablets purchased at drug stores in Washington have been examined in the Dairy Division laboratory. It was found that while some of them sometimes contained the Metchnikoff bacillus it was present in such very small numbers that it could be detected only with difficulty. When

these tablets were added to sterile milk they never, even under the most favorable temperature conditions, produced a clean acid curd. The milk was curdled, but with a rennet curd, and showed every evidence of the presence of peptonizing and gas-forming bacteria and yeasts. One tablet which was advertised to contain "5,000,000 active Metchnikoff units" was found to contain something over one million bacteria, nearly all of which were of the class usually considered as undesirable inhabitants of the digestive tract.

It is very easy to test the purity and activity of these dried cultures. Thoroughly pasteurize a small quantity (about half a pint) of milk by holding it, in a bottle plugged with cotton, at or near the boiling point for an hour or more. When this has cooled add two or three of the tablets and keep in a very warm place overnight. It should not be below and may be a few degrees above blood heat. If in this

time the milk has not curdled with a sharp acid taste and without gas bubbles and whey there can be no reason for using these tablets except the possibility that they contain the active element of the culture which

retards the growth of other bacteria. The evidence on this point is so inconclusive that it need not be considered in this connection.

The results of examinations of these and similar tablets and powders reported by other laboratories agree with the observations of the writer in indicating that at the present time little dependence can be placed on dried cultures of *B. bulgaricus*.

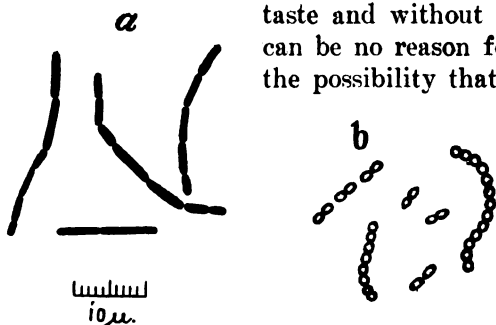


FIG. 4.—Organisms causing fermentation of milk.
a, *Bacillus bulgaricus*; b, lactic-acid bacteria.

BUTTERMILK.

Buttermilk, properly speaking, is the by-product resulting when milk or cream is churned for butter making. It is the milk remaining after the fat has been collected in globules and removed. If cream is churned when sweet the buttermilk does not differ from ordinary skimmed milk, but if it is churned when sour—the usual practice—the acidity is sufficient to coagulate the casein in the cream. In the churning process this curd is broken up into very fine particles. These curd particles settle very slowly, and if the buttermilk is agitated occasionally it will retain its milky appearance. When the buttermilk is allowed to stand undisturbed for several hours the curd particles sink to the bottom leaving an opalescent whey at the top. At the present time a large part of the buttermilk sold in cities is not made by churning cream, but is simply soured skimmed milk

which has been churned or stirred in order to break up the curd. The same product is sold also under the name of ripened milk.

The souring of milk or cream is brought about by the activity of certain bacteria which form lactic acid by decomposing the milk sugar (lactose). The ability to form acid from lactose and other sugars is possessed by many kinds of bacteria, but is so characteristic of a certain group that they are commonly spoken of as the lactic-acid bacteria (see fig. 4, *b*). These bacteria have been described as distinct species or varieties under many names. Among these may be mentioned *Bacterium guntheri*, *Bacillus acidi lactici*, *Streptococcus lacticus*, and many others. In spite of the confusion in nomenclature it is evident that the term "lactic-acid bacteria" includes a fairly well-defined group of closely related varieties possessing in common several definite characters. Variations from the type in minor characters produce an almost infinite number of varieties. These variations may be in the ability to ferment different sugars, in the tendency to grow in chains, in the kind of flavor formed in milk, in the intensity of acid formation, and in the ability to produce pathological conditions in animals.

In many creameries the cream is allowed to sour spontaneously. In this case many bacteria other than the true lactic bacteria will take part in the acid formation, and in addition to lactic acid the buttermilk may contain in small quantities acetic, succinic, and formic acids, and sometimes traces of alcohol. The lactic bacteria form lactic acid, with only slight traces of other organic acids, no alcohol, and no gas. In well-managed creameries the acid fermentation is assisted and controlled to some extent by the use of a starter. This may be good milk allowed to sour spontaneously, or buttermilk from the previous day's churning, but careful butter makers build up starters from commercial cultures. These cultures are sold in the form of powders, tablets, or fluid cultures, as varieties of lactic-acid bacteria selected with special reference to the production of a desirable flavor in butter. The butter maker puts this culture in about a quart of milk which has been steamed for an hour or more to reduce the bacteria to the lowest possible number. After standing overnight this milk will usually be curdled, but gas bubbles and other evidences of contamination may be observed. A small portion of this milk is transferred to another bottle of milk prepared as before, and this process is continued until the acid fermentation has become sufficiently active to eliminate the contaminating bacteria, and the milk curdles with a clean acid taste and without signs of gas or "wheying off." This small starter, or "mother starter," is carried along indefinitely by daily transfers to freshly steamed milk. If reasonable precautions are taken to prevent contamination and to insure the thorough heating of the milk, this culture will remain pure and vigorous for an indefinite time.

To prepare the starter actually used in ripening the cream, a larger lot of milk—25 to 50 gallons or more, according to the amount of cream—is heated for an hour or more. This is usually done in a special apparatus (sold by creamery supply houses) which consists of a large can inclosed on the sides and bottom by a steam jacket and fitted with a belt-driven stirrer. Milk either skimmed or unskimmed is heated by turning steam into the jacket; during the heating the milk is stirred constantly. After the pasteurization is completed cold water is run into the jacket and the milk cooled to about 24–27° C. (75.2–80.6° F.). A bottle of the mother starter is added and the can is covered and allowed to stand overnight. This gives a large and active pure culture of lactic-acid bacteria to start the acid formation in the cream. More uniform results are obtained if the cream is first pasteurized.

When lactic-acid bacteria grow in milk the lactose is converted into lactic acid with slight traces of certain other organic acids. This acid breaks up the combination of calcium phosphate and casein which holds the casein in solution, and the casein is precipitated as a firm jelly-like mass. When this occurs in cream the fat globules are entangled in the precipitated casein. In the process of churning the casein is broken into fine particles and the fat globules are collected into large granules that float on the top of the buttermilk. Buttermilk, then, is the water of the milk holding the sugar, acids, ash, and other soluble constituents in solution and the finely divided particles of precipitated casein in suspension. The amount of fat in the buttermilk depends on the thoroughness with which the fat is collected in the churning. Even with the best methods a little of the fat in the form of very small globules remains in the buttermilk. On standing, the suspended casein settles slowly to the bottom.

The composition of an average buttermilk is about as follows:^a

	Per cent.
Fat.....	0.5
Casein.....	2.4
Albumen.....	.6
Lactose.....	5.3
Ash.....	.7
Total solids.....	9.5

Chemically, buttermilk differs but little from milk. Only a slight rearrangement is necessary to bring about the physical change in the casein. If the milk has been pasteurized at a high temperature, the albumen is precipitated and the larger part lost. A small part—less than one-fifth—of the milk sugar is converted into acid. This acid combines with the ash constituents, probably converting the tri-

^a Vermont Agricultural Experiment Station. Annual Report, 1891, p. 119.

phosphates to di-phosphates and mono-phosphates and the di-phosphate to mono-phosphate. It is obviously not necessary to make butter in order to secure a perfect substitute for buttermilk. Soured skim milk has all the chemical properties of buttermilk, and if it is thoroughly agitated in order to break up the curd it agrees in appearance and flavor with buttermilk obtained by churning cream.

In making buttermilk from milk the same procedure should be followed as in making a starter for cream ripening. A good, clean-flavored "mother starter" should be carried along with every possible precaution to prevent contamination. Good commercial cultures can be obtained, but if it is not convenient to use one of these a natural starter can be secured. For this purpose select milk from several sources, put it into steamed bottles or glass jars, and allow these samples to stand in a warm place until they have soured. Prepare milk for inoculation by steaming or holding a sufficient number of bottles of clean, fresh milk in boiling water for about an hour. When these are cool add to each one from 5 to 10 per cent of milk from those samples that have given the curd with the least evidence of contamination and the most agreeable acid taste. The first sample should contain a high percentage of lactic-acid bacteria. In the second transfer these develop quickly and other varieties are soon suppressed by the acid formed. If there is no added contamination, extraneous forms should soon be entirely eliminated.

After three or four transfers one of these at least should sour in twelve or fifteen hours at room temperature with a clean-flavored acid curd. Gas bubbles or the separation from the curd of a milky or straw-colored whey show that the lactic-acid bacteria are still mixed with other kinds. Considerable variation in flavor can be found in different cultures, and care should be exercised to select one that gives a clean and sharp taste.

Milk to be used for making buttermilk should be fresh and clean flavored. Good buttermilk can not be made from milk that is tainted or too old to be used for other purposes. Skimmed, partly skimmed, or whole milk, as desired, may be used. More uniform and satisfactory results can be secured by destroying the bacteria as completely as possible. If a continuous pasteurizer is used for this purpose the milk should be heated to 82° C. (180° F.) or 85° C. (185° F.). If cans or other holding devices are used—and this method is to be preferred—the milk may be heated to 82° C. (180° F.) or more and held for thirty minutes to an hour. The scorched taste which results from pasteurization at this temperature is not objectionable, as it is obscured by the acidity of the soured milk. The time of the inoculation may be arranged to suit the convenience of the maker and can be determined by experience in each individual case. Using the same culture and holding the temperature uniform,

the amount of the starter can be adjusted to bring the acidity to the curdling point at any definite time within narrow limits. The temperature of the milk should be between 21° and 24° C. (70° and 75° F.). More rapid development of acid can be obtained at higher temperatures, but at the lower temperatures the lactic-acid bacteria are more successful in checking the growth of digesting and gas-forming bacteria. At lower temperatures and with a slower development of acid the casein is precipitated in a finer and more friable curd than at temperatures inducing a more rapid acid production. As soon as a fine curd has been formed the milk should be cooled promptly to below 50° F. to prevent the contraction and toughening of the curd. The curd should be thoroughly broken up by churning as soon as the milk has cooled to the proper temperature. The buttermilk is then ready for bottling, and should be smooth, free from lumps, and show a separation of whey and curd only on long standing.

A more uniform product can be obtained if it is made on a large scale, and if good buttermilk can be purchased from a reliable milk dealer at a reasonable price it is not advisable to attempt to make it on a small scale. However, it is possible to make buttermilk in the home by following in a small way the directions for making buttermilk on a commercial scale. It is necessary first to secure a culture or starter, which is merely milk containing the lactic-acid or sour-milk bacteria free or very nearly free from other kinds. These bacteria are present in any normal milk, and it is only necessary to provide conditions favoring their growth to obtain them in a state of purity. To secure this starter or culture the following procedure should be followed: Steam or boil a bottle holding 4 to 8 ounces for half an hour; fill it two-thirds full of fresh milk and put in a plug of cotton or cover with an inverted glass. Hold this at the ordinary room temperature until the following day, when a second bottle should be prepared in the same way. Put this bottle of milk in water, bring the water to a boil, and hold in this way for about an hour. After cooling to below blood heat add a teaspoonful of the milk from the first bottle. On the following day a third bottle of milk should be heated and inoculated from the second bottle. If the third bottle does not give a curd with a clean acid taste free from gas and whey it should be discarded and the entire process repeated. After the culture is obtained it is not necessary to maintain a small starter to inoculate the milk to be soured for use. Start the buttermilk by heating a quart bottle or jar of milk in boiling water at least a half hour. Cool to below blood heat and add a tablespoonful of the soured milk from the small bottle. When this has soured cool the milk by setting the jar on ice or in cold water, and break up the curd by shaking. Start the buttermilk for the following day with a tablespoonful of this buttermilk, or pour the buttermilk from the bottle

in which it is made, and without washing fill the bottle with heated and cooled milk to sour for the following day. Sufficient sour milk will cling to the sides of the bottle to inoculate each succeeding quantity. One of the vacuum jacketed bottles will be found very convenient for this purpose because the milk can be held at a nearly constant temperature favorable to the growth of the lactic-acid bacteria.

Butter makers in the Northwest make a very refreshing and nutritious drink by adding sugar and lemons to buttermilk. As the casein is already precipitated, the acid juice of the lemon has no effect. Slightly more sugar and lemon juice are necessary than in making ordinary lemonade, and the mixture should be well iced.

KEFIR.

Fermented milks have evidently been extensively used by the people of southern Russia, Turkey, the Balkan countries, and their neighbors for many centuries. The natives have no records and few traditions of the origin of the milks they use, and it is probable that their preparation and use developed gradually by accident and cumulative experience. One of the first of the fermented milks known to Europeans was the kefir, made in the Caucasus Mountains and neighboring regions from the milk of sheep, goats, and cows. Kefir differs from most of the fermented milks of the Mediterranean countries in that it is made from a dried preparation and contains considerable quantities of alcohol and gas. Kefir is made by many tribes under varying names, as "hippe," "kepi," "khapon," "kephir," "kiaphir," and "kaphir," all of which are said to come from a common root signifying a pleasant or agreeable taste.

The mountaineers of the Caucasus depend for a large part of their food on kefir, which they prepare in leather bottles made from the skins of goats. In the summer the skins are hung out of doors either in the sun or in the shade according to the weather, but in winter they are kept in the house. The bags are usually hung near a doorway, where they may be frequently shaken or kicked by each passer-by. Fresh milk is added as the kefir is taken out, and the fermentation continues. Made and propagated in this way, foreign bacteria become mingled with the essential bacteria of the grains, and abnormal and frequently disagreeable flavors result. When the milk is drawn off, in order to prevent the escape of gas, a string is first tied around the neck of the leather bottle, so that the small part wanted for use is held between the stricture and the opening. In the villages and the low country kefir is made in open earthen or wooden vessels and most of the gas escapes.

Small, yellowish, convoluted masses are observed in kefir, which are called seeds or "grains." These grains consist of a central fila-

ment of two parts, of which the outer spreads out, forming the convoluted polyp-like exterior. These parts are built up one upon another, giving the large grains a coral-like appearance. The central part is made up of a mass of bacterial threads. In the exterior, yeast cells are found mingled with the bacteria. When the grains are added to milk they swell and increase in size by forming new grains. At the beginning of the fermentation they settle to the bottom, but in a short time they are carried to the surface by attached bubbles of gas. If the fermentation is active, a thick layer will be formed on the surface, but on shaking or stirring this layer settles again to the bottom.

The biology of kefir was studied by Kern ⁴² in 1881; but, owing to the faulty technique of that day, his descriptions are evidently erroneous.

Freudenreich ²³ describes four organisms that he isolated from kefir grains. One of these was a yeast which he designated *Saccharomyces kefir*; this he found to grow best at 22° C. (72° F.), but not at all at 35° C. (95° F.). It ferments maltose and cane sugar, but not lactose. It gives a peculiar flavor to milk, but causes no fermentation. The cells are oval, 3 to 5 microns by 2 to 3 microns. It is not identical with the ordinary beer yeasts. Two of the organisms were of the lactic-acid bacteria type, but differed from them in forming gas in lactose media. The most interesting of the organisms described is a long, slender bacillus corresponding to one described by Kern as *Dispora caucasica* and to which Freudenreich gave the name *Bacillus caucasicus*. In morphology, failure to grow on ordinary laboratory media, and in high acid production in milk, this bacillus resembles very closely the bacillus mentioned later in connection with yoghurt as *Bacillus bulgaricus*. If Freudenreich's description is accurate, *B. caucasicus* differs from *B. bulgaricus* by forming gas from lactose and in being feebly motile. At 35° C. (95° F.) it produced 0.2025 per cent of acid in nine days. Gas was formed slowly at this temperature and still more slowly at 22° C. (72° F.). No one of these organisms alone produced kefir, but when the four together were grown in milk typical kefir was produced on the first or second transfer.

According to the investigations of Nikolaiewa,⁶⁰ three organisms are always present in the fermented milk. One of these, *Bacterium caucasicum*, which forms the filament of the grain, is evidently identical with Freudenreich's *Bacillus caucasicus*. This investigator considers this bacterium, with a torula yeast fermenting lactose, dextrose, and cane sugar, as essential to the production of kefir. Other bacteria and yeasts are found in the grains and the fermented milk, but they are looked upon as contamination.

It is probable that kefir is produced under different circumstances by different organisms. Any combination of bacteria or of bacteria and yeasts that will produce a lactic-acid and a mild alcoholic fermentation in milk will make kefir, although to secure the most desirable flavor certain organisms may be essential.

Hammarsten²⁹ shows the changes brought about in cow's milk by this fermentation in the following table:

Chemical analysis of kefir.

	Two days old.	Four days old.	Six days old.
Casein.....	2.570	2.586	2.564
Lactalbumen.....	.425	.405	.390
Peptones.....	.071	.089	.120
Lactose.....	3.700	2.238	1.670
Fat.....	3.619	3.630	3.626
Ash.....	.641	.624	.630
Lactic acid.....	.665	.832	.900
Alcohol.....	.230	.810	1.100

It will be observed that the changes were confined almost entirely to the lactose and its by-products. The casein remained unchanged and the increase in the peptones was insignificant. The lactalbumen decreased slightly. The casein of kefir is, according to this chemist, not especially soluble, but may be more easily digestible because of its finely divided condition. The lactose diminished appreciably, and there was a corresponding augmentation of alcohol and lactic acid. A certain part of the lactose is consumed in the formation of carbon dioxid gas not included in this analysis.

The following directions are given for making kefir when the grains are available: The dry grains are softened by soaking in warm water, which should be changed several times. When the grains rise to the surface and become white and gelatinous they are ready for use. One part of these grains is used to three parts of milk which has been thoroughly heated to destroy the bacteria already present. The bottles in which the milk and grains are placed should not be stoppered but should be protected from the dust by cloths, inverted cups, or plugs of cotton. They are held at a temperature at or near 14° to 16° C. (57° to 60° F.), and stirred or shaken frequently. After eight to ten hours the milk is strained through cloth and put in tightly stoppered bottles at the same temperature as before. The bottles should be shaken every few hours to prevent the formation of lumps of precipitated casein. The kefir is ready for use at the end of twenty-four hours. If it is held longer than this it is advisable to keep it on ice to check the fermentation. The temperature at which the milk is fermented is important in controlling the relative amounts of alcohol and lactic acid. At higher temperatures the percentage of alcohol is increased, while as

the temperature is lowered the alcoholic fermentation diminishes and the quantity of lactic acid formed is greater. After the fermentation is once started the grains may be discarded and new kefir made by adding one part of the fermented milk to three or four parts of fresh milk. In order to remove the grains the kefir should be strained through cheese cloth, and after thorough washing to remove the curd the grains may be dried by exposure to the sun on pieces of blotting paper. In this condition they are said to retain their vitality for several years, although many of the yeasts in the outer part of the grain are killed by the desiccation. It may be necessary to break up the grains with the fingers. They should not be larger than a walnut when in the wet stage.

Kefir grains can not ordinarily be obtained in this country, but a good imitation of kefir can be made by carrying on simultaneously in sealed bottles an alcoholic and a lactic fermentation. Better results can be obtained by inducing the alcoholic fermentation in buttermilk. In this way it is possible to avoid much of the trouble from the formation of lumps of curd. If buttermilk is made for this purpose from whole or skimmed milk, careful attention should be given to the time of curdling and the breaking up of the curd. This is essential to a smooth, creamy kefir. Ordinary bread yeast may be used for the alcoholic fermentation, but as this yeast does not ferment lactose it is necessary to add cane sugar to the milk. Prepare the yeast on the day before the buttermilk is ready by adding a half teaspoonful of sugar to a 6 or 8 ounce bottle of boiled and cooled water. Add half of a yeast cake to this sugar solution and set in a warm place overnight. This will give an active culture of the yeast and obviates the necessity of adding the yeast cake directly to the milk.

On the quantity of sugar added to the buttermilk will depend the extent of the alcoholic fermentation. Theoretically about one-half of the sugar fermented may be converted to alcohol; that is, milk to which 1 per cent of cane sugar has been added may contain after the fermentation one-half of 1 per cent of alcohol. The quantity of sugar added should be governed by the amount of carbon dioxide it is desired to have in the finished product. This should be sufficient to make the kefir distinctly effervescent and impart to it the peculiar sharp taste of charged water, but should not be developed enough to blow the fluid out of the bottles when the stoppers are removed. Experience shows that 1 to $1\frac{1}{2}$ per cent of sugar will give the right amount of gas. This may be approximated by adding sugar in the proportion of 2 even teaspoonfuls of sugar to each pint of milk.

Having the buttermilk and the yeast culture ready, dissolve the sugar in the buttermilk and add the yeast culture in the proportion of 1 teaspoonful to a quart of buttermilk. Mix thoroughly and

bottle. The bottles should be very strong, as sufficient gas pressure is sometimes generated to break ordinary bottles. The heavy bottles used for ginger ale or other carbonated drinks answer this purpose very well. The bottles should be carefully cleaned and boiled or steamed before filling. Fill them full and stopper tightly, wiring or tying the stoppers securely in place.

The alcoholic fermentation should be carried on at a comparatively low temperature. If the fermentation is too active the kefir will have a yeasty taste and the curd is likely to become lumpy and filled with large gas bubbles. A temperature of 18° C. (65° F.) to 21° C. (70° F.) will be found satisfactory for kefir which is to be used on the third or fourth day. The floor of a cool cellar is a convenient place to ferment kefir made in the home. The bottles should be shaken as often as may be necessary to keep the curd in a finely divided condition. The finished product should be smooth and creamy, effervesce rapidly when poured from the bottle, and have the pleasant acid taste of buttermilk with the added sharpness due to the gas and the trace of alcohol. Kefir 2 or 3 days old may have a yeasty taste, but if it has been properly made this will disappear as the fermentation of the sugar nears completion. Kefir made under these conditions should be used when 3 to 5 days old, but if it is put on ice it may be held for a week or even longer.

KUMISS.

The missionary monks and other wanderers who first penetrated the undulating, treeless plains of European Russia and central and south-western Asia brought back descriptions of a fermented drink which in the light of more recent investigations is easily recognized as kumiss. These vast prairies are inhabited by tribes of nomads who live in squalid huts or tents in the winter and wander during the summer, seeking pasture for their horses, their herds of cattle, or flocks of sheep. They are all horsemen, and by a process of selection in which they have probably played only a passive part have developed an exceptionally hardy race of horses. The mares give much more than the ordinary amount of milk, which constitutes almost the entire food of the people during the summer. This is never used in the fresh condition, but is fermented to make kumiss. Unlike kefir, there is no dried "ferment," "seeds," or "grains" with which the fermentation of the mare's milk is started. It is the practice of the natives, when it becomes necessary to establish the fermentation anew, to add to milk some fermenting or decaying matter, such as a piece of flesh, tendon, or vegetable matter. Whatever the material used to supply the essential organisms, it is evident that the milk is so cared for that a combination of an acid and an alcoholic fermentation is favored and the necessary bacteria and yeasts are soon established.

No doubt the change in the milk is produced under different circumstances by different combinations of bacteria and yeasts, and there are usually present various contaminating organisms which are detrimental or at least are not essential to the production of the kumiss. Native kumiss makers lay great stress on the quality of the milk, the breed of the mares, and the condition of the pastures; but it is probable that their troubles ascribed to variations in these conditions are more likely due to imperfectly controlled bacteriological factors.

There was at one time much interest in kumiss as a therapeutic agent in the treatment of tuberculosis, and sanatoria were established in Russia where invalids could be given this treatment. It is probable that the benefits, real or imaginary, derived from this treatment came more from the general methods, which corresponded somewhat to present practices, than to the action of kumiss.

Mare's milk is lower in nutritive value than cow's milk, as the following table, taken from Richmond's Dairy Chemistry, shows:

Average composition of cow's milk and mare's milk.

	Water.	Fat.	Sugar.	Casein.	Albumen.	Ash.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Cow.....	87.10	8.90	4.75	3.00	0.40	0.75
Mare.....	90.06	1.09	6.65	1.89		.31

The composition of kumiss varies somewhat with the age, the rapidity of the fermentation, and the nature and extent of contamination with extraneous organisms. The following analysis is taken from Richmond's Dairy Chemistry (p. 241):

Composition of kumiss made from mare's milk.

	1 day old.	8 days old.	22 days old.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Water	91.43	92.12	92.07
Alcohol.....	2.67	2.93	2.98
Lactic acid	.77	1.08	1.27
Sugar.....	1.63	.50	.23
Casein.....	.77	.85	.83
Albumen.....	.25	.27	.24
Albumose.....	.98	.76	.77
Fat.....	1.16	1.12	1.80
Ash.....	.35	.35	.35

It will be observed that this fermentation produces no changes that could be expected to increase appreciably the digestibility of the nitrogenous part of the milk except the possible advantage of a finely divided curd. Mare's milk differs from cow's milk in giving with rennet a softer, more friable curd, but it is not certain that this property would increase the value of kumiss.

Kumiss is often made and offered for sale in this country, but as this is usually made from cow's milk, it is, more correctly, kefir.

YOGHURT, ETC.

In passing to a consideration of the fermented milks used by the people of the countries bordering on the eastern end of the Mediterranean we find a preparation very distinct from that of the Caucasus and the Russian steppes. Kefir and kumiss are limpid, mildly acid, and distinctly alcoholic; but the yoghurt, yahourth, or jugurt of the Turks, the kissélo mléko of the Balkan people, the mazun of Armenia, the gioddù of Sardinia, the dadhi of India, and the leben or leben raib of Egypt are all thick curdled milks, decidedly acid, and with very little or no alcohol. The method of preparation is also quite different. Goat's, buffalo's, or cow's milk may be used. This is usually boiled and sometimes is reduced by evaporation to one-half its original volume. In the latter case it is not used as a drink, but is eaten, frequently with the addition of bread, dates, or other food.

A portion of the previously fermented milk is used to ferment the fresh milk. Unlike kefir, there are no "seeds" through which the fermentation can be transmitted, but the essential organism is sometimes preserved by drying the fermented milk and reducing the dry material to a powder. This constitutes the "podkwassa," or "maya." The organism giving these milks their distinctive character is evidently identical in all of them, or, more properly speaking, may be any one of the several varieties of a distinct and closely related group. On account of its peculiarities, some of which are exceptional and striking, and the importance recently attached to it by the discussions both in the scientific and the popular press, a brief résumé of its characteristics is given:

This bacterium was probably first observed by Kern,⁴² who incorrectly designated it *Dispora caucasicum*. His description, however, is so limited that it is impossible to attach the name he proposes to any particular organism. Later Beyerinck,⁶ under the name *Bacterium caucasium*, and Freudenreich,²³ as *Bacillus caucasicus*, described organisms isolated from kefir which agree in their essential features with those obtained from yoghurt. More recently Rist and Khoury⁶⁶ isolated from Egyptian leben two bacilli to which they gave the names *Strepto-bacillus lebenis* and *Bacillus lebenis*. Grigoroff²⁷ and Cohendy¹³ isolated similar organisms from Bulgarian fermented milk. These various bacteria are undoubtedly nearly or quite identical and are all included under the name *Bacillus bulgaricus*, now generally adopted. More strict adherence to the commonly accepted rules of bacteriological nomenclature would retain the name *Bacterium caucasicum* proposed by Beyerinck. Recent work by Hastings³⁰ and by Heinemann and Hefferan³⁴ indi-

cates that this bacterium is not peculiar to the eastern fermented milks, but is widely distributed, having been isolated from milk, soil, saliva, feces, and various soured foods. White and Avery⁷⁶ believe that this bacterium is the representative of a group of closely related bacteria which they divide into two types on the basis of their activity in milk and the nature of the lactic acid formed. The characteristics of the typical culture may be summarized as follows:

Morphology.—Slender rods 2 microns to 6 or 8 microns in length, breadth usually about 1 micron, flagella and spores absent. Long chains frequently occur and apparently vary with different strains and conditions; pseudobranching has been observed. Very long threads without apparent division are frequently observed in old cultures. Living cells are gram positive, dead cells are gram negative.

Growth on artificial media.—One of the most striking features is its inability to grow on ordinary media. It grows on whey, malt, and slowly on whey agar and certain specially prepared media. The colonies on whey agar are masses of tangled threads resembling colonies of the anthrax bacillus. Gelatin is not liquefied.

Relation to oxygen.—Most varieties grow equally well in the presence or absence of oxygen.

Temperature relations.—The maximum temperature is near 45° C. (113° F.). The minimum growth temperature varies with different members of the group, but it is always comparatively high. Most varieties grow very slowly at 25° C. (77° F.), but some grow at 20° C. (68° F.). Hastings and Hammer³¹ state that at 20° C. (68° F.) it forms 4 per cent acid in milk as compared with a maximum of 3 per cent at 37° C. (98° F.). According to White and Avery⁷⁶ it is killed by an exposure of fifteen minutes at 60° C. (140° F.).

Fermentation of sugars.—Many of the sugars are fermented, but statements of different workers are conflicting. It is probable that this property varies in different varieties.

Milk.—The action of this organism on milk distinguishes it from all other known bacteria. At the optimum temperature milk is curdled in a few hours with a rather soft curd, frequently somewhat slimy, which does not separate from the whey even on long standing. In twenty-four hours the milk may show acidity equivalent to nearly 2 per cent of lactic acid, and on standing several days this may become about 3 per cent. The most active of the ordinary lactic-acid bacteria seldom exceed 1 per cent lactic acid. The more active type of *Bacterium caucasicum* forms the inactive lactic acid, while the levorotatory acid is produced by the type forming acid more slowly. Small amounts of other organic acids are formed, and traces of alcohol.

This bacterium is evidently the essential organism of yoghurt, matzoon, ceiddu, leben, and similar fermented milks. Other bacteria are always present, some of them habitually and others only occasionally. Some of these may have an influence on the flavor while others are inert. It is probable that there are none, with the exception of *Bact. caucasicum*, that could not be replaced by other species without appreciably affecting the results. Different localities have doubtless developed slightly different varieties of fermented milk due to different combinations of bacteria or of bacteria and yeasts. The Egyptian leben is reported to contain alcohol, but not in sufficient quantities to produce an effervescence such as is observed in kefir or kumiss. One of the ordinary lactic-acid bacteria seems always to be present with the *Bact. caucasicum*, and it is probable that if it is not essential it is of some assistance in starting the lactic fermentation and, especially if the temperature is low, in suppressing contamination before the *Bact. caucasicum* has time to develop sufficient acid to check extraneous bacteria.

Hastings and Hammer³¹ could not detect evidences of proteolytic enzymes by the usual tests, but found in old milk cultures a distinct peptonization of the casein which was not due to the action of the acid. This change is so slow and so small that it can not be considered as having any influence on the digestibility of the milk. Otherwise the only changes in the milk constituents are in the conversion of the sugar to lactic acid and very small amounts of volatile acids and traces of alcohol.

"Yoghurt buttermilk" is now sold in several cities, and the growing demand will doubtless soon extend its manufacture more generally. In making yoghurt in this country better results are secured by using with the *Bact. caucasicum* a culture of an ordinary lactic-acid organism such as is used in making buttermilk. *Bact. caucasicum* growing alone in milk forms usually a rather slimy tenacious curd which can not be broken up into the smooth creamy condition essential to a good buttermilk. If this organism is grown in combination with the ordinary lactic-acid organism, a more friable curd is obtained and the sliminess is not so evident. The two organisms can be carried in mixed culture only with great difficulty, as the high acid soon suppresses the ordinary form. The most satisfactory results can be obtained by making buttermilk in the ordinary way and churning it with an equal quantity of milk curdled with the yoghurt organism. This procedure gives the desirable texture of buttermilk and a distinctive flavor.

If a culture can be obtained, yoghurt can be made in the home with little difficulty. Heat the milk—for example, one quart—by holding the bottle submerged to the level of the milk in boiling water for a half hour. Cool the milk, slowly at first, by displacing the hot water

with cold water. When the milk is cooled to about 40° C. (104° F.) add one teaspoonful of the culture. The milk should be held at a temperature as near 40° C. (104° F.) as possible. If the temperature is higher the curd is likely to be lumpy and tough; if the temperature is lower than 37° C. (98° F.) the fermentation is slower and the danger of the development of contaminating organisms is greater. The proper temperature is easily maintained by the use of one of the vacuum jacketed bottles now in general use. When these are available the procedure may be varied slightly from that given above. It may be more convenient to heat the milk in a double boiler ordinarily used for cooking cereals. Keep the water boiling for a half hour. It may be cooled by filling the outer receptacle with cold water. Cool the milk to 40° C. (104° F.), transfer to the insulated bottle, and add a teaspoonful of the culture. After about eighteen hours the milk is curdled and ready for use. It should be transferred to a clean milk bottle, capped or covered with an inverted glass, and put on ice to cool. If the yoghurt is not kept cold the acidity will continue to develop until it becomes unpalatable. The insulated bottle should be thoroughly washed and rinsed with boiling water and the cork stoppers should be boiled frequently. The process is then repeated, using for a culture a teaspoonful of the freshly curdled milk. The yoghurt may be made more palatable by adding to two parts of the yoghurt one part of cold water, or, better still, cold charged water, which can be bought in siphons at drug stores. Sugar and lemon juice or other fruit flavors or chocolate sirup may also be used for this purpose. The sugar should be added in the form of a sirup, as granulated sugar dissolves very slowly in the cold yoghurt. If the yoghurt has gas bubbles or a yeasty or a bitter flavor it has become contaminated with foreign organisms. The contamination may be removed by fermenting the milk at a higher temperature for three or four days, thus producing conditions unfavorable to the growth of the foreign organisms. The milk should be put into the insulated bottle at 49° C. (120° F.). This will give a high acid and a lumpy curd, but the contamination should be eliminated in three or four days.

BIBLIOGRAPHY.

The following bibliography, while not exhaustive, contains the more important papers on fermented milks and will be useful to those who care to take up this question in more detail:

1. ARNOLD, R. Contribution à l'étude des laits fermentés. Le leben. [Thèse. 44 p. Montpellier.] Abstract in Koch's Jahresbericht über die Fortschritte in der Lehre von den Gährungs-Organismen, vol. 10, p. 226. Leipzig, 1899.
2. BALDWIN, HELEN. Observations on the influence of lactic acid ferments upon intestinal putrefaction in a healthy individual. *Journal of Biological Chemistry*, vol. 7, no. 1, p. 37-48. Baltimore, December, 1909.

3. BELONOVSKY, J. Influence du ferment lactique sur la flore des excréments des souris. *Annales de l'Institut Pasteur*, vol. 21, no. 12, p. 991-1004. Paris, December 25, 1907. Abstract in *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*. Abt. 2, vol. 21, no. 13/14, p. 431, Jena, July 25, 1908.
4. BERTRAND, GABRIEL, and DUCHAÏEK, F. Action du ferment bulgare sur les principaux sucres. *Annales de l'Institut Pasteur*, vol. 23, no. 5, p. 402-414. Paris, May 25, 1909.
5. BERTRAND, GABRIEL, and WIESWEILLER, GUSTAVE. Action du ferment bulgare sur le lait. *Annales de l'Institut Pasteur*, vol. 20, no. 12, p. 977-990. Paris, December 25, 1906.
6. BEYERINCK, MARTINUS W. Sur le kéfir. *Archives Néerlandaises des Sciences Exactes et Naturelles*, vol. 23 (old series), p. 428-444. The Hague, 1889.
7. BIEL, J. Untersuchungen über den Kumys und den Stoffwechsel während der Kumyskur. 51 p. Vienna, 1874.
8. BRUDZINSKI, J. Ueber das Auftreten von proteus vulgaris in Säuglingsstühlen nebst einem Versuch der Therapie mittelst darreichung von Bacterienculturen. *Jahrbuch für Kinderheilkunde und Physische Erziehung*, vol. 52, no. 3, p. 469-484. Berlin, October 10, 1900.
9. BRUHN, F. Kefir und Kumyss. *Zeitschrift für Fleisch und Milchhygiene*, vol. 16, no. 6, p. 181-184. Berlin, March, 1906.
10. BRUSH, EDWARD F. Kumyss. 20 p. [n. d., n. p.]
11. CARRICK, GEORGE L. Koumiss or fermented mare's milk and its uses in the treatment and cure of pulmonary consumption and other wasting diseases. With an appendix on the best methods of fermenting cow's milk. 294 p. Edinburgh and London, 1881.
12. COHENDY, MICHEL. Essais d'acclimatation microbienne persistante dans la cavité intestinale. Délimitation du siège probable de cette acclimatation. *Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, vol. 60 (année 58, tome 1), no. 7, p. 364-366. Paris, Feb. 23, 1906.
13. COHENDY, MICHEL. Description d'un ferment lactique puissant capable de s'acclimater dans l'intestin de l'homme. *Comptes Rendus de la Société de Biologie*, vol. 60 (année 58, tome 1), no. 11, p. 558-560. Paris, March 30, 1906.
14. COHENDY, MICHEL. De la désinfection intestinale obtenue, sans régime spécial, par l'acclimatation d'un ferment lactique dans le gros intestin. *Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, vol. 60 (année 58, tome 1), no. 13, p. 602-604. Paris, April 6, 1906.
15. COHENDY, MICHEL. Essai de traitement de l'entérite muco-membraneuse aiguë par l'acclimatation d'un ferment lactique dans le gros intestin. *Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, vol. 60 (année 59, tome 1), no. 18, p. 872-874. Paris, May 25, 1906.
16. CONRADI, HEINRICH, and KURPJUWEIT, O. Ueber spontane Wachstumshe-mmung der Bakterien infolge Selbstvergiftung. *Münchener Medizinische Wochenschrift*, vol. 52, no. 37, p. 1761-1764. Munich, Sept. 12, 1905.
17. CONRADI, HEINRICH, and KURPJUWEIT, O. Ueber die Bedeutung der bakteriellen Hemmungsstoffe für die Physiologie und Pathologie des Darms. *Münchener Medizinische Wochenschrift*, vol. 52, no. 45, p. 2164-2168, and no. 46, pp. 2228-2232. Munich, Nov. 7, 14, 1905.
18. CRITHARI, C. Étude sur la symbiose du bacille bulgare et du bacille butrique. *Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, vol. 64, no. 16, p. 818. Paris, May 15, 1908.

19. DÜGGELI, MAX. Bakteriologische Untersuchungen über das armenische Mazun. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, Abt. 2, vol. 15, nos. 19/20, p. 577-600. Jena, Dec. 28, 1905.
20. EMMERLING, OSKAR. Ueber armenisches Mazun. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten. Abt. 2, vol. 4, no. 10, p. 418-421. Jena, May 27, 1898.
21. ENGEL, FRIEDRICH. Yoghurt oder saure Milch und ihre Fabrikations-Methoden. Molkerel-Zeitung, vol. 22, no. 51, p. 1461-1463. Hildesheim, Dec. 19, 1908.
22. ESAULOW, N. Bakteriologische und chemische Untersuchung des Kefir. [Diss. Moskau, Pharmazeutische Zeitschrift für Russland, vol. 34, p. 232.] Abstract in Koch's Jahresbericht über die Fortschritte in der Lehre von den Gährungs-Organismen, vol. 6, p. 222. 1895.
23. FREUDENREICH, EDWARD VON. Recherches bactériologiques sur le kéfir. Annales de Micrographie, vol. 9, p. 5-33. Paris, 1897.
24. FUHRMANN, FRANZ. Über Yoghurt. Zeitschrift für Untersuchung der Nahrungs- und Genussmittel, vol. 13, no. 10, pp. 598-604. Berlin, May 15, 1907.
25. GEBHARD, FRITZ. Ueber Kephir, seine Bereitung und therapeutische Verwerthung. Inauguraldissertation. Würzburg, 1884.
26. GRAABE, K. B. Yoghurt. Mælkeritidende, vol. 22, no. 1, p. 8-12. Odense, Jan. 1, 1909. Abstract in Milch-Zeitung, vol. 38, no. 10, p. 112-113. Leipzig, Mar. 6, 1909.
27. GRIGOROFF, STAMEN. Étude sur un lait fermenté comestible. Le Kiséomléko de Bulgarie. Revue Médicale de la Suisse Romande, année 25, no. 10, p. 714-721. Geneva, Oct. 20, 1905.
28. HALLION, L. Le kéfir. Presse Médicale, vol. 8, no. 48, p. 265-267. Paris, May 30, 1900.
29. HAMMARSTEN, OLOF. Untersuchungen von Kefir. [Upsala Läkareför. Förhand., vol. 21, p. 1-32. 1886.] Abstract in Biedermann's Centralblatt für Agrikulturchemie und Rationellen Landwirtschafts-Betrieb, vol. 17, p. 413-417. Leipzig, June, 1888.
30. HASTINGS, EDWARD G. A preliminary note on a group of lactic acid bacteria not previously described in America. Science, vol. 28, no. 723, p. 656. New York, Nov. 6, 1908.
31. HASTINGS, EDWARD G., and HAMMER, B. W. The occurrence and distribution of organisms similar to the *B. bulgaricus* of yoghurt. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, Abt. 2, vol. 25, no. 14/18, p. 419-426. Jena, Dec. 22, 1909.
32. HAYEM, GEORGES. Indications thérapeutiques du képhir. Presse Médicale, no. 78, p. 617-620. Paris, Sept. 28, 1904.
33. HEINEMANN, PAUL G. Lactic acid as an agent to reduce intestinal putrefaction. Journal of the American Medical Association, vol. 52, no. 5, p. 372-376. Chicago, Jan. 30, 1909.
34. HEINEMANN, PAUL G., and HEFFERAN, MARY. A study of *Bacillus bulgaricus*. Journal of Infectious Diseases, vol. 6, no. 3, p. 304-318. Chicago, June 12, 1909.
35. HENNEBERG, WILLIAM. Yoghurt. Milch-Zeitung, vol. 37, no. 43, p. 506-509. Leipzig, Oct. 24, 1908.
36. HERSCHELL, GEORGE A. On the use of selected lactic acid bacilli and soured milk in the treatment of some forms of chronic ill-health. Lancet, vol. 175, no. 4432, p. 371-374. London, Aug. 8, 1908.

37. HERSHELL, GEORGE A. Soured milk and pure cultures of lactic acid bacilli in the treatment of disease. 32 p. London, 1909.
38. HERTER, CHRISTIAN A. On certain relations between bacterial activity in the intestine and the indican of the urine. *British Medical Journal*, no. 1930, p. 1847-1849. London, Dec. 25, 1897.
39. HERTER, CHRISTIAN A. On the therapeutic action of fermented milk. *Popular Science Monthly*, vol. 74, no. 1, p. 31-42. New York, Jan., 1909.
40. HERTER, CHRISTIAN A., and KENDALL, A. I. An observation on the fate of *B. bulgaricus* (in Bacillac) in the digestive tract of a monkey. *Journal of Biological Chemistry*, vol. 5, no. 2/3, p. 293-302. Baltimore, Oct., 1908.
- 40^a. HERTER, CHRISTIAN A., and KENDALL, A. I. The influence of dietary alternations on the types of intestinal flora. *Journal of Biological Chemistry*, vol. 7, no. 3, p. 203-236. Baltimore, Feb., 1910.
41. KEFIR. *Pure Products*, vol. 4, no. 6, p. 245-248. New York, June, 1908.
42. KERN, EDUARD. Ueber ein Milchferment des Kaukasus. *Botanische Zeitung*, vol. 40, no. 16, p. 263-264. Leipzig, Apr. 21, 1882.
43. KERN, TIBOR. [Effect of the Yoghurt bacillus [*Bacillus bulgaricus*] on the *Bacterium coli*. Orvosi Hetilap, p. 416. 1909.] Abstract in *Zentralblatt für die Gesamte Physiologie und Pathologie des Stoffwechsels*, vol. 10 (neue Folge, vol. 4), no. 21, p. 843. Berlin, Nov., 1909.
44. KLOTZ, MAX. Zur Bakteriologie des Yoghurts. *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Abt. 2, vol. 21, no. 13/14, p. 392-398. Jena, July 25, 1908.
45. KLOTZ, MAX. Ueber Yoghurtmilch als Säuglingsnahrung. *Jahrbuch für Kinderheilkunde und Physische Erziehung*. III F, Band 67, Ergänzungsheft p. 1-56. Berlin, 1908. Abstract in *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Abt. 2, vol. 22, no. 14/17, p. 437. Jena, February 5, 1909.
46. KOUMISS. *Pure Products*, vol. 3, no. 12, p. 559-562. New York, December, 1907.
47. KRAKAUER, I. Nähr- und heilwerth des echten Kefirs in Krankheiten der harnsauren Diathese und anderen Fällen. *Wiener Medizinische Presse*, vol. 39, no. 4, p. 134-142. Vienna, January 23, 1898.
48. KRANNHALS, H. Ueber das kumys-ähnliche Getränk "Kephir" und über den "Kephir"-pilz. *Deutsche Archiv für Klinische Medizin*, vol. 35, no. 1-2, p. 18-37. Leipzig, July 2, 1884.
49. LEEDS, ALBERT R. *Foods for Invalids and Infants*. New Jersey dairy commissioner, annual report, p. 37-47. Trenton, 1887.
50. LERSCH. Die Kur mit Milch und den daraus Getränken (Molken, Kumys). 90p. Bonn, 1869.
51. LEVA, J. Zur Beurteilung der Wirkung des Lactobacillins und der Yoghurtmilch. *Berliner Klinische Wochenschrift*, vol. 45, no. 19, p. 922-924. Berlin, May 11, 1908. Abstract in *Biochemisches Centralblatt*, vol. 7, no. 14, p. 546. Leipzig, June, 1908.
52. LUERSEN, ABTUB, and KÜHN, M. Yoghurt, die bulgarische Säuermilch. *Centralblatt für Bakteriologie Parasitenkunde und Infektionskrankheiten*, Abt. 2, vol. 20, no. 8/9, p. 234-248. Jena, January 10, 1908.
53. MCFARLANE, ARTHUR E. Prolonging the prime of life. *Metchnikoff's discoveries show that old age may be postponed*. *McClure's Magazine*, vol. 25, no. 5, p. 541-551. New York, September, 1905.
54. METCHNIKOFF, ELIE. The prolongation of life; optimistic studies. Translated by P. Chalmers Mitchell. New York, 1906. Chapter 5.

55. METCHNIKOFF, ELIE. The utility of lactic microbes with explanation of the author's views on longevity. *Century Magazine*, vol. 79, no. 1, p. 53-58. New York, November, 1909.
56. MICHELS, JOHN. Manufacture and marketing of cottage cheese, skim milk, buttermilk, and ice cream. *North Carolina Agricultural Experiment Station Bulletin* 202. West Raleigh, May, 1909.
57. MORO, ERNST. Ueber den *Bacillus acidophilus* n. spec. Ein Beitrag zur Kenntniss der normalen Darmbacterien des Säuglings. *Jahrbuch für Kinderheilkunde und Physische Erziehung*, vol. 52, no. 1, p. 38-55. Berlin, July 7, 1900.
58. MORRES, W. Die Bereitung von Yogurt (yoghourt). *Milch Zeitung*, vol. 38, no. 42, p. 497-498. Leipzig, October 16, 1909.
59. MÜLLER, WALTER. Die verschiedenen Arten gegorener Milch. *Molkerlei Zeitung*, vol. 19, no. 44, p. 517-518. Berlin, October 30, 1909.
60. NIKOLAIEWA, E. G. Die Mikroorganismen der Kefirs. *Bulletin du Jardin Impérial Botanique de St. Petersbourg*, vol. 7, no. 4, p. 121-142. 1908. Abstract in *Milchwirtschaftliches Zentralblatt*, vol. 5, no. 2, p. 91. Leipzig, February, 1909.
61. NORTH, CHARLES E. Reports of 300 cases treated with a culture of lactic-acid bacteria. *Medical Record*, vol. 75, no. 13, p. 505-514. New York, March 27, 1909.
62. OLSCAHNETZKY, M. A. Untersuchung über den Stoffwechsel während der Kephyrcur. *Deutsche Medizinische Wochenschrift*, vol. 16, no. 27, p. 589-592. Leipzig, July 3, 1890.
63. PABST. Fabrication du lait champagnisé et du kéfir. [*L'Agriculture Moderne*, 1903.] Abstract in *Revue Générale du Lait*, vol. 3, no. 7, p. 165-166. Lierre, January 15, 1904.
64. PIFFARD, HENRY G. A study of sour milks. *New York Medical Journal*, vol. 87, no. 1, p. 1-9. New York, January 4, 1908.
65. PODWYSOTZKY. Le képhir. 76 p. Paris, 1902.
66. RIST, EDOUARD, and KHOUBY, JOSEPH. Etudes sur un lait fermenté comestible. Le "leben" d'Egypte. *Annales de l'Institut Pasteur*, vol. 16, no. 1, p. 65-84. Paris, January 25, 1902.
67. [ROSENTHAL, GEORGES, and CHAZARAIN-WETZEL, P. Essais de bactériothérapie clinique (Première communication). De l'emploi des ferments lactiques (bacille bulgare et streptocoque lactique) dans le traitement des infections chirurgicales des voies urinaires et de la vessie en particulier. *Bulletin Général de Thérapeutique Médicale*, vol. 158, p. 17. July, 1909.] Abstract in *Biochemisches Centralblatt*, vol. 9, no. 1-2, p. 50. Leipzig, September, 1909.
68. SAMARANI, F. "Cieddu." [*Annuario della Reale Stazione Sperimentale di Caselfico di Lodi*. Lodi, 1907, p. 95-98.] Abstract in *Experiment Station Record*, vol. 20, no. 5, p. 477. Washington, January, 1909.
69. SCHIPIN, D. Ueber den Kumysbacillus. *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Abt. 2, vol. 6, no. 23, p. 775-777. Jena, December 4, 1900.
70. SEVERIN, S. A. Einige Ergebnisse und Bemerkungen über den sogenannten *Bacillus bulgaricus* und das Milchsäurepräparat "Lactobacilline." *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Abt. 2, vol. 22, no. 1/2, p. 3-22. Jena, November 7, 1908.
71. STANISLAUS, I. V. S. Kefir and its preparation. *American Journal of Pharmacy*, vol. 80, no. 1, p. 20-26. Philadelphia, January, 1908.

72. STEKHOVEN, J. H. Schuurmans. *Saccharomyces kefir*. Onderzoekingen gedaan in het Physiologisch Laboratorium der Utrechtsche Hoogeschool, vol. 2, p. 119. Utrecht, 1891.
73. THEODOROFF, J. Historische und experimentelle Studien über den Kephir. Inaugural dissertation. Würzburg, 1886.
74. TISSIER, HENRY. Etude d'une variété d'infection intestinale chez le nourrisson. *Annales de l'Institut Pasteur*, vol. 19, no. 5, p. 273-297. Paris, May, 1905.
75. WEIGMANN, H., and others. Ueber armenisches Mazun. *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*. Abt. 2, vol. 19, no. 1/3, p. 70-87. Jena, July 16, 1907.
76. WHITE, BENJAMIN, and AVERY, OSWALD T. Observations on certain lactic acid bacteria of the so-called bulgaricus type. *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*. Abt. 2, vol. 25, no. 5/9, p. 161-178. Jena, November 30, 1909.

O

136.073

U58

B95c

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY,
UNIV. OF MICH.

JUN 18 1911

172

THE OSTRICH INDUSTRY IN THE UNITED STATES.

BY

A. R. LEE,

Junior Animal Husbandman, Animal Husbandry Division.

[Reprinted from the Twenty-sixth Annual Report of the Bureau of Animal Industry (1909).]



WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

ORGANIZATION OF THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

THE OSTRICH INDUSTRY IN THE UNITED STATES.

By A. R. LEE,

Junior Animal Husbandman, Animal Husbandry Division.

HISTORY.

Ostrich farming is in its infancy in the United States, the first ostriches having been imported in 1882. Other importations followed, but it was some time before success was obtained in the reproduction of ostriches in this country. The first ostrich breeders in the United States learned through experience alone, as there was available very little information on ostrich breeding and management and no data concerning their care and management as adapted to climatic and soil conditions in this country.

DISTRIBUTION AND ADAPTATION.

From these importations the ostrich farms have been built up and breeders have located in various parts of the United States, so that to-day there are ostrich farms in Arizona, Arkansas, California, Florida, and Texas. Complete statistics of the number of ostriches in this country are not available, but reports received from all of the large and the majority of the smaller ostrich farms show that there were at least 6,100 breeding or feather-producing ostriches in the United States in January, 1910. These ostriches were distributed among the States approximately as follows: Arizona, 80 per cent; California, 17 per cent; Arkansas, 2 per cent; while Texas and Florida together reported less than 1 per cent of the total number in this country.

Ostriches apparently thrive best in a warm, dry climate, but they have not been tried extensively enough under other climatic conditions in the United States to see whether or not they may become adapted to a climate where the precipitation is greater. The precipitation during the year 1908 in the various States in which ostriches are raised was as follows: Arizona, 15.15 inches;* Arkansas, 48.88 inches; California, 18.78 inches; Florida, 47.33 inches; Texas, 32.91 inches.

* Figures furnished by the Weather Bureau.

ERADICATING CATTLE TICKS IN CALIFORNIA.

By **WILLIAM M. MACKELLAR**, *Veterinary Inspector in Charge*,
AND

GEORGE H. HART, *Assistant in Pathology and Bacteriology*.

CONDITIONS PRIOR TO COMMENCEMENT OF ERADICATION WORK.

The history of the Texas-fever cattle tick in California covers scores of years. On account of its dating back long before the tick was known to be in any way connected with Texas fever, and at a time when differentiation of infectious diseases of bovine animals was little understood, resulting in anthrax, blackleg, and Texas fever being confused with each other and all classed under the lay term of "murrain," there is no way of ascertaining the exact origin of the tick in this State.

The common wood tick and castor-bean tick are very numerous in parts of California and are found on the cattle and horses in great numbers at certain seasons of the year. It is natural, therefore, that the invasion of the country by the deadly fever ticks attracted but little attention for a long time after their appearance and until they had secured a firm foothold.

Pioneer cattlemen of the State have different views as to the source from which the fever ticks were introduced. Thus it is held by some that they were brought across the Rocky Mountains on feeder cattle shipped into this country from Texas. As Mexico, however, has probably been infested since the early conquests of the Spanish, it is most plausible to consider that California received her first Texas-fever ticks from cattle driven across the line from Lower California.

Until recent years the entire country was open range and movements of cattle were not controlled. The ticks, therefore, having been seeded in this country, and attracting no suspicion from cattlemen, had ample opportunity to spread and involve more of the southern section of the State. In every infested locality some one cattleman, who on account of having carried on the cattle business on a large scale involving the shipping in of cattle from other sections of this State and from other States, is accredited by his neighbors with the responsibility for bringing the ticks into that particular section.

When the Texas-fever quarantine line was first placed across the United States in 1891 as a result of investigations by Dr. D. E. Salmon, the State of California was not included in the quarantined area. In 1894 outbreaks of Texas fever in Nevada, Kansas, and Missouri were reported as apparently caused by cattle originating in California. On account of these outbreaks of disease Mr. W. E. Hill, an inspector of the Bureau of Animal Industry, was directed to proceed to California and make an investigation. His investigation revealed that a large part of this State was permanently infested with Texas-fever ticks, and that great numbers of cattle had died of the disease in this State. The limits of the infested area not having been definitely determined, the entire State was subsequently placed below the federal quarantine line. Further investigation, however, having shown that the northern part of the State was free of ticks, the line was gradually moved south, so that in 1906 it crossed California at the northern limits of San Luis Obispo, Fresno, Madera, and San Bernardino counties, thus including the 13 southern counties of the State. All of the territory south of this line was not infested, on account of portions of the country being unfavorable to the propagation of the ticks. Although many of the counties in the quarantined territory had appointed live-stock inspectors, their duties involved attention to all infectious diseases, and movements of cattle within a county were without restriction. In this way all those sections favorable to the development of ticks became permanently ticky ranges, although in many instances they were separated by miles of mountainous desert, or extremely dry lands, where, on account of lack of feed, cattle could not remain the year round. Hence the ticks, even if well seeded on this land, failed to secure a permanent foothold.

Cattlemen learned, even before ticks were in any way connected with Texas fever, that certain ranges were dangerous for cattle, and thus in many instances after the loss of nonimmune cattle that had been placed on a ticky range this land was left free of cattle, and the starvation method of cleaning the land of ticks was thereby unconsciously accomplished. Thus areas within the State were constantly being cleaned, while others, on account of the early-day practice of driving a herd of cattle away from a range on which they were dying, became seeded. Such a condition of affairs existed when, in July, 1906, under the congressional appropriation for tick eradication, the Bureau of Animal Industry started the work of eradicating the ticks in California in cooperation with the State officials.

The work at first consisted in locating the ticky ranches and educating the owners of such land to the losses they were sustaining from the ticks and the benefits they would derive from eradicating them. This required careful and repeated inspections of all the cattle south of the quarantine line, and when completed showed San Luis

Obispo, Santa Barbara, San Diego, Orange, Fresno, and Ventura counties to be heavily infested, and Tulare, Kern, Kings, Los Angeles, Riverside, San Bernardino, and Madera counties to be infested to a lesser degree. These counties comprised 69,755 square miles of territory, and contained 660,027 head of cattle, of which 153,476 were on tick-infested ranges.

LOSSES FROM THE TICKS.

The loss to the cattle industry south of the quarantine line in California from ticks has been enormous. This has been especially the case in this State on account of the topography of the country. In all the quarantined counties there is high mountainous land, or dry land with very hot summers, where ticks do not thrive. As a result there was constantly being raised, even in some very ticky counties, thousands of head of cattle yearly that reached maturity without ever becoming infested with ticks, and hence were not immune to Texas fever. From adverse feed conditions, as cold in the mountains or drought in the dry lands, cattle would from time to time be brought to more favorable feeding places, usually along the coast, which in the majority of cases were tick infested, and almost immediately they would commence to die in wholesale numbers. The mountain cattleman called the disease "coast fever," and from bitter experience learned to leave their cattle in the mountains or dry lands during adverse years, sustaining more or less heavy losses from starvation, rather than bring them to the coast on good feed only to stand much heavier losses from Texas fever.

Also, in the driving of cattle to favorable feeding places 50 to 100 miles distant, they would frequently be driven through some valley in the mountains that was tick infested; and although perhaps only remaining there overnight, in a short time afterwards, when miles away from the ticky valley, the cattle would start to die, and losses of from 50 to 100 head in this manner were not uncommon.

With the breaking up of many of the large ranges in California the raising of cattle to the fattening stage early became cheaper in the more remote States, as Arizona, Utah, Nevada, New Mexico, and western Texas, which were free of ticks. Thus many feeders, all nonimmunes, were annually shipped from these States to California to be fattened on the native grasses. Such cattle, when brought to ticky ranges in this State, died in such large numbers that the practice, while very profitable in the absence of ticks, had to be abandoned in many localities. Single cattlemen have been known to lose an entire train load of such cattle in a short time.

Among the immune cattle raised on ticky ranges, toward the end of the dry season, when feed was poor and ticks were so numerous as

to "shingle" the cattle, a yearly loss ranging from 3 to 10 per cent was sustained, while on all of these places since eradicating the ticks this loss is entirely obviated.

On the grossly infested ranges it was sometimes necessary for stock owners to get off their beef cattle before they were in prime condition, rather than keep them until later in the season, when, from the heavy infestation, they would fall off instead of gain.

In some of the quarantined counties the trading in cattle became so hazardous as to be almost abandoned, owners being afraid to buy or move stock on account of great losses sustained by neighbors on all sides from such a procedure.

In the counties where dairying is the main industry, the shrinkage in milk production among the grossly infested herds during the summer and fall, while hard to estimate accurately, would increase the economic loss from the ticks to a considerable extent.

A great saving to the railroads in car disinfection has also been accomplished, since a large part of the original area quarantined in the State has been released.

EARLY METHODS OF COMBATING GROSS INFESTATION.

Prior to the commencement of the eradication work many ranges containing fine feed were so heavily infested with ticks that raising and fattening cattle on them was a difficult problem. The cattlemen in many instances did not believe in the so-called tick theory of Texas fever, but they considered that from their enormous numbers the ticks were an injury on account of the parasitic existence they maintained on the cattle, which was constantly demonstrated by the large percentage of deaths among immunes during times when feed was short. It therefore was a general practice for ranchers in the summer and fall to resort to various methods to destroy the ticks. The time and labor expended in this procedure were great and their value slight and of a very temporary duration. On some of the ranches the range cattle were corraled, roped, and treated one at a time by hand, either by currying off the ticks or applying various solutions, as crude oil, coal-tar preparations, kerosene oil, or carbolic acid, which in all cases killed only a portion of the ticks and often injured the hides of the cattle more or less seriously. On the very large ranches, containing many thousand head, treating all the cattle individually was impossible, and after corraling a bunch only those most heavily infested were picked out for treatment. Even this absolutely ineffective method required weeks of labor.

In other cases, wild cattle would be crowded into chutes and sprayed through openings in the sides, by which method it was impossible to wet with the solution the parts of the animals where the ticks were most numerous. In the dairy herds spraying and swab-

bing were resorted to at irregular intervals. On some ranches chickens were accredited with assisting in retarding tick development by entering the corral and feeding on the adult ticks picked from the bodies of cattle in the recumbent position.

On one large grant of land comprising 17,000 acres along the ocean front, it was the custom to drive the cattle into the ocean and hold them against the bluffs where the waves could beat against them. This mechanical action of the waves had the effect of dislodging the large ticks, and they dropped into the ocean, where they perished. The measure, although very crude, was easy of accomplishment and resulted in some benefit.

Owners of some of the larger ranches in order to combat ticks built dipping vats. These they filled with water, on the surface of which a thin float of oil or distillate was placed, in some cases not over one-quarter to one-half inch thick. Cattle were rounded up and run through such vats when the ticks became too numerous, but the permanent good so derived was slight.

IMPORTANCE OF STATE LAW.

On account of actual tick-eradication work being in no way connected with the interstate movement of cattle, federal laws are inoperative with regard to cattle kept within a State. It is therefore essential that Bureau employees engaged in this work be deputized under the state law so that they may carry out all the various provisions of a practicable tick-eradication law.

While in all cases it expedites matters and is more pleasant for the cattle owners and inspectors to work harmoniously in the eradication of the ticks, a stringent state law is absolutely necessary, as there are always a few stockmen who refuse to see the advantage to themselves and the community in eradicating this pest. In order to compel such indifferent owners to disinfect their cattle properly a state law should be enacted giving the state authorities the power to enforce disinfection and making it a misdemeanor for the owners not to comply with such requirements.

Through the efforts of the state veterinarian, Dr. Charles Keane, the State of California, in March, 1907, enacted a law which makes it a misdemeanor to move or expose tick-infested cattle in such a manner as to infest other cattle or live stock not so infested. This law also provides for the disinfection of cattle as directed by the state veterinarian or his deputy, and provides that in case of failure on the part of the owner so to disinfect, the state veterinarian has the power to disinfect the cattle, the cost of the treatment becoming a lien on them. This law, while having weak points that should be corrected to cover certain special conditions, has been of inestimable value in the work of tick eradication in California.

METHODS USED IN TICK ERADICATION IN CALIFORNIA.

On account of the present high valuation of range lands, the absence of feed-lot methods of fattening, and the stocking of all sections to the full capacity with live stock, the practice of "resting" pastures to clean them is impracticable in the great majority of cases in California. This method, however, is one which gives rapid results with little work, and when the number of cattle on the ranch will permit of its use it is an easy method of accomplishing the desired results. In this State it is recommended that all cattle, horses, mules, and asses be excluded from the resting pasture for eight months, resting preferably to begin between May 1 and October 1, when all tick eggs that may be on the pasture are sure to hatch before the approach of cold weather.

From the lack of rains during the summer season and the excessive valuation of irrigable lands, where forage crops could be raised for use in the pasture-rotation method, this resource for ridding a ranch of ticks has also been impracticable.

Tick eradication therefore resolved itself into a problem of cleaning the ranges while the cattle were constantly grazing upon them. Under such conditions the first essential to success is the installation of a dipping vat. It has been our experience under usual conditions in this State that time used in spraying, smearing, currying, hand picking, or other means without the dipping vat is mostly wasted. These latter methods may be entirely successful with single cows, but where there are a dozen head or more such measures require two or three years, and before success is attained the owner is discouraged and disgusted. When the herd comprises over 50 head, it has, in our experience, proved to be practically impossible to clean without the vat.

After the vat is installed the owner must be thoroughly informed at the beginning what will be required of him to clean his ranch, and impressed with the possibility of freeing his land and cattle in one season. His cooperation is necessary, but even when this is given constant supervision by the inspector is necessary to prevent laxity and overlooking of details which are absolutely essential to success. Thus on a ranch containing infested cattle a single improper mixing of the dipping solution or the failure to get a few head to the vat at a dipping in the middle of the dipping season may destroy the opportunity of cleaning the ranch with that year's work.

Although the eradication work in one community has been very successful and cleaning of the ranches has proceeded without interruption, this fact when used as an argument for thorough and regular dipping in another section often has little effect on obstinate owners of tick-infested land.

During the process of cleaning, which entails time, labor, and expense on the part of the cattleman, he is almost sure to become discouraged; and when, after having dipped his cattle three or four times, they continue to come up to the vat for the fourth or fifth dipping showing ticks, he commences to feel that his efforts are going to be in vain. At this stage of eradication even the most enlightened cattlemen who appreciate the benefit of exterminating the ticks are liable to become so discouraged as to be disagreeable when approached by the inspector in regard to further dipping. At this time tact on the part of the inspector is very essential. Many cattlemen who have made irritating and even insulting remarks to the inspectors during the time of actual eradication work have, after this was completed and when they realized that their ranches were free of the pest, become strong in their praise of the work and the economic good it has done them personally and will do the country at large.

During the dipping season, when the ranches are heavily infested, horses, mules, and burros running on the range require attention, and should be dipped or otherwise freed from ticks. When there is slight infestation of the range, solipeds require little attention.

The dippings can be separated by intervals of thirty days under ordinary circumstances when the infestation is slight or moderate. When the range is very heavily infested it is better to dip at shorter intervals, twenty-one to twenty-eight days, for several months or until the ticks begin to show a reduction in numbers, when the intervals between dippings may be extended to thirty days. When infested cattle are to be moved to a tick-free pasture, two dippings must be required, separated by an interval of five to fourteen days.

The dipping season in California begins about April 1 and must continue at thirty-day intervals until eight or nine dippings have been made in order to clean the range in one season. During these eight or nine months it is necessary for the inspector to be present at each dipping and supervise the mixing of the dipping fluid in person. He should know the exact number of cattle on each infested ranch, and where possible should count the cattle at every dipping as they are let out of the draining pen, to be sure that the owner has made a clean roundup.

On the slight or moderately infested ranges after several dippings the cattle will often come to the vat apparently free from ticks, and the owner will therefore object to further dipping. In such cases the absolute necessity for continuing the disinfection throughout the season must be impressed upon him.

In many localities in California where infestation existed the country was divided up into small ranches, 40 to 120 acres. Such ranches were separated by a single line of barbed-wire fence, and all con-

tained cattle. Upon ranch-to-ranch inspection of such localities, in many instances ranches would be found tick free when surrounding them on one or more sides ticky cattle were known to be grazing. Such ranches were kept under close observation throughout the eradication work, and remained clean. It is thus seen that it is quite practicable for a single line of good fence to prevent the spread of the Texas-fever tick. As a result of our observations in this matter it would seem to be unnecessary to augment the cost of eradication by insisting on double division fences.

In dividing large ranges by cross fences, for the purpose of tick eradication, as far as possible the single fence should be made to traverse rough, inaccessible land where feed is short and where cattle will consequently have little tendency to stray directly up to the fence.

INTERNATIONAL FENCE.

Tick eradication along the California-Mexico line is complicated by the fact that parts of Lower California, especially the coast section, is heavily infested with ticks. It being largely a range country, badly tick-infested live stock from that country were constantly drifting and straying across the international line and undoing any efforts of the American ranchers in this section to eradicate the ticks from their land. Consequently it became apparent that if the ticks were to be eradicated in this locality it would be necessary to control this movement of tick-infested Mexican live stock. Without such control ranchers in this section consider it a hardship to have to attempt to free their land of ticks, only to have it reinfested by stray Mexican animals, and, consequently, their cooperation in the work can not be secured.

The only feasible method of securing this control of live stock is the construction of a stock-proof fence on or near the international line. The necessity for such a fence has long been recognized by the ranchers in this section, and some, to protect their feed and to assist in freeing their cattle of ticks, have constructed fences of a more or less temporary character at irregular intervals along the line; but in most cases it has been necessary to abandon the eradication work in this section pending the construction of a proper fence. It was soon ascertained that such a fence could not be constructed without government assistance. The Bureau of Animal Industry has therefore undertaken to construct a first-class stock-proof fence along this line, wherever necessary, to prevent the entrance of infested Mexican live stock. With this fence installed, eradication in this section will soon be accomplished and future reinfestation prevented. Such a fence will also assist the customs officials in preventing illegal traffic between the two countries.

DIPPING SOLUTION, ITS PREPARATION AND USE.

At the commencement of the work by the Bureau in the summer and fall of 1906 the oil-float dip was used. This was prepared by filling the vat with water, after which 1 to 2 inches of oil was floated on the surface. The oil used was a California product, and while samples from several wells seemed to be nearly identical with Beaumont oil, injurious results to the cattle of a more or less serious nature followed in most instances. This probably was largely due to the extreme heat of California summers and the absence of shade on the ranges. While ticks on the cattle were killed by this measure when properly carried out, reinfestation soon occurred, and redippings at sufficiently short intervals to prevent reseeding of the ranges was impossible. The oil float having been found injurious, attempts to use crude petroleum alone after the methods followed in the Eastern States was abandoned. On account of the insurmountable opposition on the part of the cattlemen to the use of oil, it soon became apparent that tick eradication in this State would be impossible unless some other less injurious disinfecting solution could be obtained.

The following year the arsenical solution was tried in several vats with such satisfactory results to stock owners and inspectors that its general use was at once inaugurated and has been continued uninterruptedly to the present time. In this solution, properly prepared, cattle can be dipped nine or ten times in one season and remain in as good if not better condition than cattle on adjoining pastures with identical feed that have not been dipped.

The solution used in California is made after the following formula:

Arsenic trioxid (white arsenic)-----	pounds--	8
Sodium carbonate (sal soda)-----	do---	24
Soap (laundry or chipped)-----	do---	24
Pine tar -----	gallons--	2 or 3
Water -----	do---	500

For mixing the preparation it is necessary to have at the vat one or two caldrons or tanks of a capacity of not less than 50 gallons in which to dissolve the ingredients. As the water in the caldron warms the sodium carbonate is added and dissolved by stirring, after which the arsenic is added and the fluid brought to the boiling point and stirred until all is in solution. To expedite matters, the soap may be cut up and heated at the same time in the second caldron or dissolved in the arsenic and soda solution when only one tank is available. These three ingredients being dissolved, the fire is then drawn, and the tar is slowly added, with constant stirring to make a homogeneous solution. This concentrated solution is then added to the

water in the vat to make the proper proportion, as given in the preceding formula. When filling a large vat of a capacity of 3,000 or 4,000 gallons, several boilings have to be made, unless the cooking tank is quite large.

The soap, in our opinion, is a valuable ingredient of the preparation. It gives body to the dip and tends to make it adhere to the hides. This is important, as the solution acts as a gradual poison to the ticks, requiring several days to kill when the parasites are nearing maturity. It also cleans the hair of the cattle, thus improving their appearance after dipping, and may have a slight effect in preventing reinfestation for a longer time than when they are dipped in an arsenical solution without the soap. It also assists in emulsifying the tar and rendering the solution homogeneous. These advantages far outweigh the slight extra cost of its use. The addition of the larger quantity (3 gallons, instead of 1 gallon, as usually recommended) of pine tar is recommended, as it is also valuable in giving body to the mixture and increases its action as a parasiticide. In addition, it has been found that the greater the proportion of tar the longer cattle are free from annoyance by flies following dipping.

While the solution made after the above formula is most satisfactory for dairy and fine-bred cattle, more arsenic may be added, up to 9 or 10 pounds to the 500 gallons, in the disinfection of range cattle.

When once filled, the vat is ready for use at all times, unless rains should dilute its contents, when ingredients have to be added in the proper proportions for the amount of rain water which has fallen or drained into the tank. In exposed tanks the amount of evaporation is considerable during the hot summer months, reducing the fluid in the vats as much as 3 inches between dippings. In adding ingredients to keep the fluid at the proper depth for dipping, this evaporation does not have to be accounted for, and the medicinal ingredients should be added in full proportion for all water used. The same solution remains active as a tickicide indefinitely, but the number of times it should be used for redippings depends entirely on the number of cattle dipped each month. Dirt carried in on the hoofs; hair which comes off the animals in considerable quantities during the shedding season, and urine and feces evacuated by the cattle in the vat and draining pen tend to befoul the solution. When therefore the number of cattle dipped monthly reaches into the hundreds of head it is our practice to clean out the vat after each three dippings.

Following dipping in arsenical solution care must be used in driving cattle to prevent overheating, as injurious and even fatal results have followed forced driving, especially during hot weather.

While this solution is very poisonous, it has been used very extensively in this State with no bad results, and with ordinary precautions

its poisonous nature is not a good reason against its use. It is our practice to place on each vat in which the solution is used a notice reading as follows:

WARNING!

The fluid in this vat is

POISONOUS

to man and all animals.

Do not allow it to contaminate any feed or water supply.

Cattle should be watered before dipping.

THE DIPPING VATS FOUND MOST PRACTICABLE.

Dipping being the most practicable method of disinfecting cattle for eradicating ticks, it is necessary for those engaged in eradication work to become familiar with the various kinds of vats, in order that the most suitable form may be recommended under the various conditions met, depending on the kind and number of cattle to be treated and the financial condition of the owner.

In communities where several small tick-infested ranches are located within a short distance of each other cooperative vats have been established. The several owners of the infested places would club together, select the most convenient location to build the vat, and subscribe the necessary money for its installation. One rancher is appointed treasurer, and it is his duty to collect all money for dipping, buy the dipping materials, and act as manager of the plant. A charge is made for dipping, usually not over 5 cents a head, and if at the end of the dipping season there is a surplus this is divided among the subscribers. In this way the several ranchers have the advantage of a dipping vat without each being put to the cost of installing one. A dipping day is set once each month, and all infested herds are dipped at this time, the owners assisting each other in the operation.

In other cases one rancher will install the vat and allow his neighbors to dip their cattle in it, charging a nominal fee for the service.

In California three styles of vats are used, namely, the swim vat, the cage vat, and the wade vat.

THE SWIM VAT.

The swim vat is by far the most practical for range stock and where large numbers of cattle are to be dipped. It has the advantage of speed and requires little labor in the operation of dipping. The longer such a vat can be constructed, up to 50 or 60 feet at the dip line, the better, as it has been found that the action of the arsenical solution is more potent if the cattle are submerged for at least twenty

seconds, and such a length of time is recommended when mature ticks are present on the cattle. However, in this State successful results have followed the use of much shorter tanks. Such vats may be

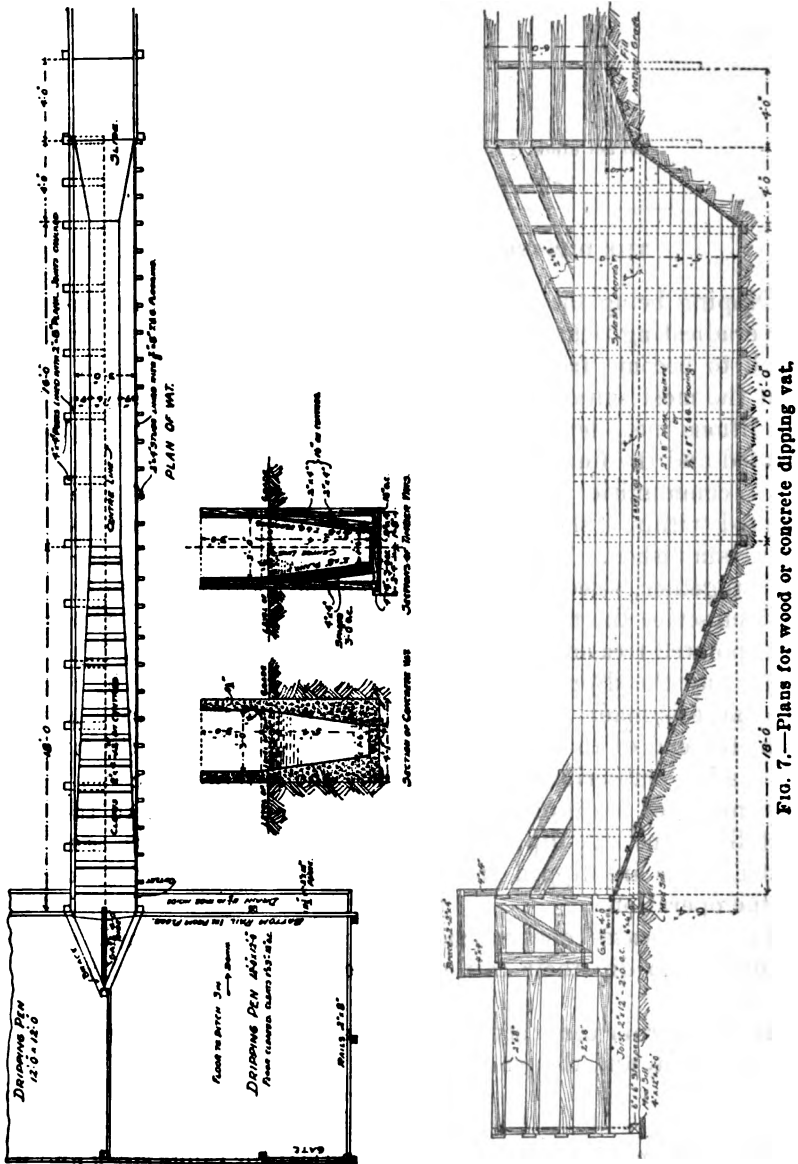


FIG. 7.—Plans for wood or concrete dipping vat.

constructed of lumber or cement. The latter is preferable, as it has not the disadvantage of leaking, which is common in wooden vats, and is more durable. A swim vat built after the plans shown in

figure 7 will prove very satisfactory. This figure, as well as the following specifications and list of materials, is taken from Farmers' Bulletin 378, by H. W. Graybill. A vat constructed according to these plans will hold 2,088 gallons when filled to a depth of 5 feet. In our experience in the use of such vats in California it has been found advantageous to construct the vat with a somewhat steeper slope at the entrance end than is indicated in the plans. With this modification the cattle are plunged more quickly into the vat, and time can be saved in dipping a large number of animals.

Excavation.—Excavate for the vat, as shown by the drawings (fig. 7), to the proper depth. Level the bottom of the pit for the sills. After the vat is completed fill in around it, using the surplus earth to bring the grade at the sides of the vat a little above the natural grade and slope the surface away from the vat. Dig the holes required for all posts, etc.

Carpenter work.—The drawings show the vat constructed according to two methods. One method is to make the sides of 4 by 4 inch posts spaced about 3 feet apart and lined with 2 by 8 inch dressed, sized, and bevel-edged plank, using 20-penny spikes to fasten them to the posts and braces. All the joints are to be calked with oakum well driven in with a calking iron and pitched. The floor of the vat and the inclines are to be made of 2-inch plank with joints calked, the exit incline to have 2 by 4 inch cleats spiked to the plank flooring. The slide should have an angle of about 25° and should be covered with No. 16 galvanized iron.

The other method is to build the sides of the vat of 2 by 4 inch posts and 2 by 4 inch braces spaced about 16 inches on centers. The 2 by 4 inch posts and braces are to be lined with $\frac{1}{2}$ by 8 inch tongued-and-grooved flooring, blind nailed at every bearing with 10-penny nails. All the joints are to be laid in white lead paste and the boards firmly driven up.

Lumber.—The lumber used in the construction of the vat must be thoroughly dried and seasoned stock, free from large and loose knots, straight grained, and free from sap.

Gutters.—The gutters for the dripping pens should be made of sound stock, the bottom plank housed into the sides and ends, and the ends housed into the sides. All the joints are to be laid in white lead paste and thoroughly nailed. Gutters are to have 3-inch fall in 11 feet.

Concrete vat.—The concrete vat should be made of concrete composed of 1 part by measure of good Portland cement, 3 parts of clean sharp sand, and 5 parts of broken rock, the broken rock to be not larger than will pass in any direction through a 2-inch ring. The rock should be washed free of dust. Concrete should be mixed wet and well tamped into place.

Bill of materials.—Lumber for vat when constructed of 2-inch material and 4 by 4 inch posts:

Sills-----	8 pieces 4 by 4 inches by 10 feet long.
Posts-----	1 piece 4 by 4 inches by 16 feet long.
	1 piece 4 by 4 inches by 14 feet long.
	6 pieces 4 by 4 inches by 12 feet long.
	5 pieces 4 by 4 inches by 10 feet long.
	1 piece 4 by 4 inches by 16 feet long.
Braces-----	6 pieces 4 by 4 inches by 12 feet long.
	1 piece 4 by 4 inches by 10 feet long.
	1 piece 4 by 4 inches by 6 feet long.

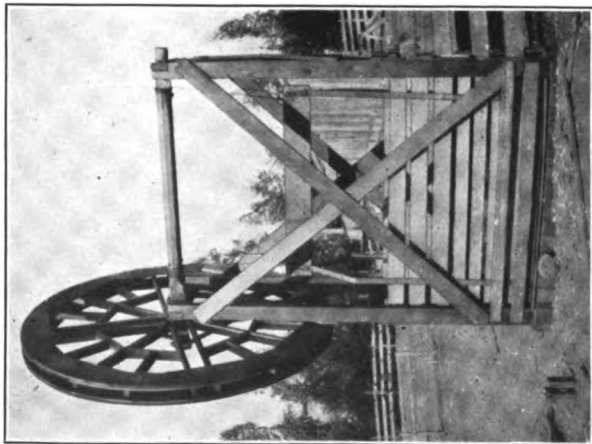
Guards-----	2 pieces 2 by 8 inches by 18 feet long.
	1 piece 2 by 8 inches by 16 feet long.
	2 pieces 2 by 8 inches by 12 feet long.
	1 piece 2 by 8 inches by 10 feet long.
Sides-----	18 pieces 2 by 8 inches by 20 feet long.
	25 pieces 2 by 8 inches by 18 feet long.
	2 pieces 2 by 8 inches by 16 feet long.
	2 pieces 2 by 6 inches by 18 feet long.
Floor-----	Dressed one side and two edges.
	Edges beveled for calking.
	3 pieces 2 by 10 inches by 20 feet long.
	2 pieces 2 by 10 inches by 16 feet long.
	1 piece 2 by 10 inches by 14 feet long.
Cleats-----	1 piece 2 by 10 inches by 7 feet long.
	1 piece 2 by 12 inches by 12 feet long.
	Dressed one side and two edges.
	Edges beveled for calking.

Lumber for vat when constructed of flooring and 2 by 4 inch posts:

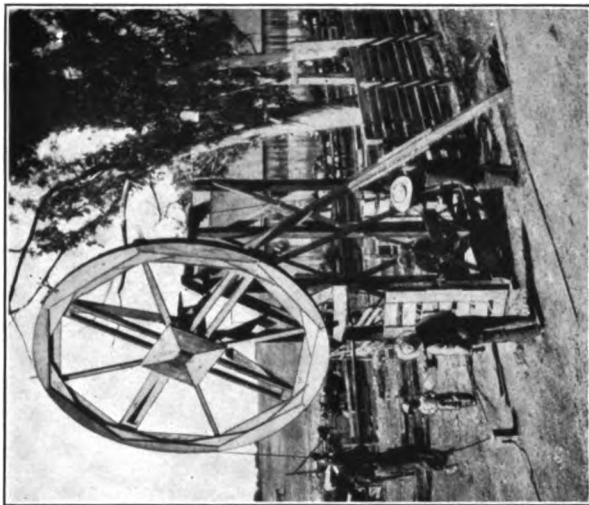
Sills-----	7 pieces 2 by 4 inches by 14 feet long.
Posts-----	28 pieces 2 by 4 inches by 18 feet long.
	4 pieces 4 by 4 inches by 11 feet long.
Braces-----	15 pieces 2 by 4 inches by 12 feet long.
	2 pieces 2 by 4 inches by 10 feet long.
Guards-----	2 pieces 2 by 4 inches by 16 feet long.
Sides-----	Materials the same as specified above.
Floor-----	550 feet b. m. $\frac{1}{4}$ by 8 inches tongue-and-groove flooring.
Cleats-----	Materials the same as specified above.

Lumber for draining pens:

Mud sills-----	10 pieces 4 by 12 inches by 2 feet long (cedar or cypress).
Sleepers-----	4 pieces 6 by 6 inches by 12 feet long.
Joists-----	13 pieces 2 by 12 inches by 12 feet long.
Floor-----	360 feet b. m. tongue-and-groove flooring $\frac{1}{4}$ by 8 inches—12-foot pieces.
Cleats-----	265 linear feet 1 by 3 inches.
Gutters-----	(Sides: 4 pieces 2 by 12 inches by 11 feet long (dressed).
	Bottom and ends: 2 pieces 2 by 12 inches by 12 feet (dressed).
	Bottom housed into sides and ends. Ends housed into sides. All joints calked and white leaded or pitched.
	11 pieces 4 by 4 inches by 7 feet long.
Posts-----	2 pieces 4 by 4 inches by 8 feet long.
	2 pieces 4 by 4 inches by 9 feet long.
	2 pieces 2 by 8 inches by 18 feet long.
Rails-----	5 pieces 2 by 8 inches by 16 feet long.
	18 pieces 2 by 8 inches by 12 feet long.

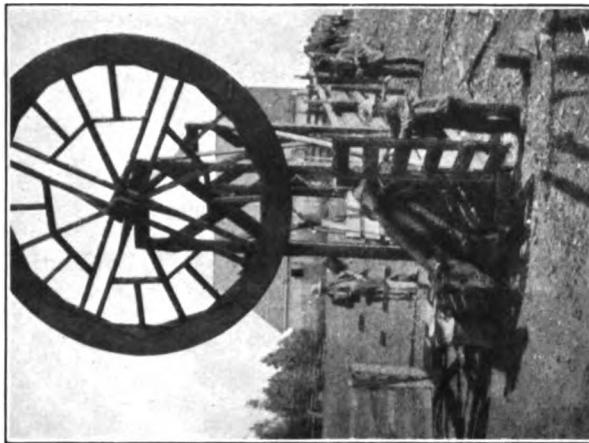


The first figure shows gross appearance of vat and apparatus.



CAGE VAT FOR DIPPING CATTLE.

The second figure shows vat with cage down and attendant ducking animal. The third figure shows vat with cage raised and animal walking out.



The third figure shows vat

Braces-----	2 pieces 2 by 4 inches by 10 feet long.
Gates-----	{ 7 pieces 1 by 6 inches by 12 feet long.
	{ 6 pieces 1 by 6 inches by 10 feet long.

Hardware for vat and draining pens:

4 pair 12-inch heavy T hinges and screws.

4 wrought-iron hooks and staples.

1 pair wrought-iron hook hinges, 12-inch wood screw hooks, and screws.

50 pounds 20-penny wire nails.

15 pounds 10-penny wire nails.

12 square feet No. 16 galvanized iron.

When vat is constructed of flooring and 2 by 4 posts, the following additional hardware will be required:

19 pounds 20-penny wire nails.

12 pounds 10-penny wire nails.

Material for concrete vat:

Concrete, 1 part Portland cement, 3 parts sand, 5 parts broken rock or gravel.

19 cubic yards broken rock or gravel.

18 cubic yards sand.

30 barrels Portland cement.

THE CAGE VAT.

The cage vat, when properly constructed, is very practical and is recommended for the disinfection of smaller herds and gentle cattle, especially dairy cows.

It has the advantages of being economical in the amount of dipping solution necessary to charge the vat; animals may be held in the solution as long as desired, and the operation of dipping is almost entirely without rough handling or worry to the cattle. This last is an important factor in the disinfection of milch cows without causing shrinkage in the milk flow. Dairy herds should be dipped in the morning immediately after milking.

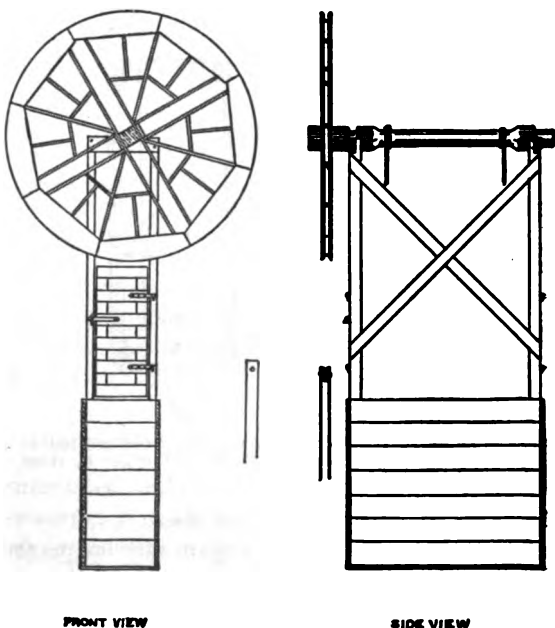


FIG. 8.—Plans for cage vat.

They can then be turned out to pasture with very little time lost from feed. Plate XV and figures 8 and 9 show this form of vat as it has

given most satisfactory results in California. The following specifications and bill of materials are given for its construction:

Tank.

The tank should be made 7 feet deep, 3 feet wide, and 8 feet long, inside measurements.

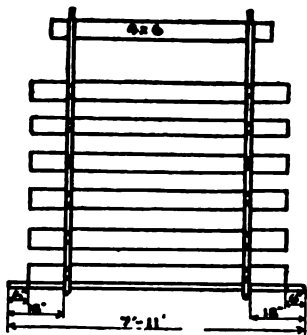
Four corner posts, 4 by 6 inches by 18 feet, must be planed on outer sides to join planks for sides and ends.

Sides, 7 planks 2 by 12 inches by 16 feet cut to 8 feet long.

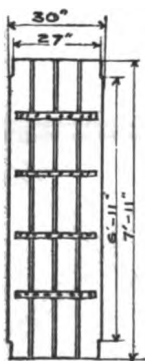
Ends, 3 planks 2 by 12 inches by 12 feet cut to 3 feet long.



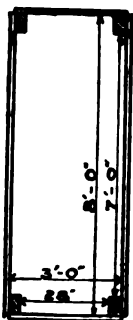
a



b



c



d

FIG. 9.—Detail plans for cage vat; *a*, Cross section of cage; *b*, side view of cage; *c*, floor of cage; *d*, cross section of tank.

Ends, 1 plank 2 by 12 inches by 16 feet cut two pieces 3 feet long; left over, 2 by 12 inches by 10 feet.

Bottom, use left-over 2 by 12 inches by 10 feet cut to 3 feet 4 inches long.

Bottom, 2 planks 2 by 12 inches by 12 feet cut to 3 feet 4 inches long.

Braces, ends, and sides, five 1 by 6 inches by 12 feet.

Gates, two 1 by 6 inches by 14 feet.

Gates, two 1 by 6 inches by 12 feet.

Gates, four hinges and two hooks.

Cage.

Floor, two 2 by 6 inches by 16 feet cut to 7 feet 11 inches long.

Floor cleats, one 2 by 3 inches by 12 feet cut 28 inches long.

Sides, six 1 by 6 inches by 14 feet cut to 6 feet 11 inches long.

Top piece, one 4 by 6 inches by 6 feet.

Make hangers of $\frac{1}{2}$ by 2-inch iron.

Wheel.

Shaft, one 8 by 8 inches

by 10 feet, turned to set in bed pieces.

Three-eighths-inch cable or chain attached to shaft to raise cage.

Bed pieces, make two 3 by 8 inches by 3 feet.

Spokes, twelve $1\frac{1}{2}$ by 3 inches by 12 feet.

Flanges, four 1 by 12 inches by 16 feet.

Have flanges extend 3 inches over ends of spokes and run rope over free ends of spokes.

Use $\frac{1}{4}$ -inch rope 140 feet long, have pulley in a block sunk in ground, and lift cage with saddle horse or horse and traces.

Lumber and milling companies furnish these materials, sized and cut in proper manner, to the ranchers for from \$55 to \$65. The builder then has in addition the labor of excavating the pit and putting the tank together. Draining pens with such vats are not essential and are rarely used, as the animal drains while the cage is being raised.

This vat is installed near the corrals and requires only a short chute leading from the corral to the cage. In operating such a vat the animal is driven through the chute into the cage and the end gate closed. The hoist rope is released and the weight of the animal carries the cage down into the fluid. If the animal is not completely submerged, its head is forced under by the foot of an assistant wearing rubber boots. After remaining in the solution the proper length of time (twenty to thirty seconds) the cage is raised by attaching

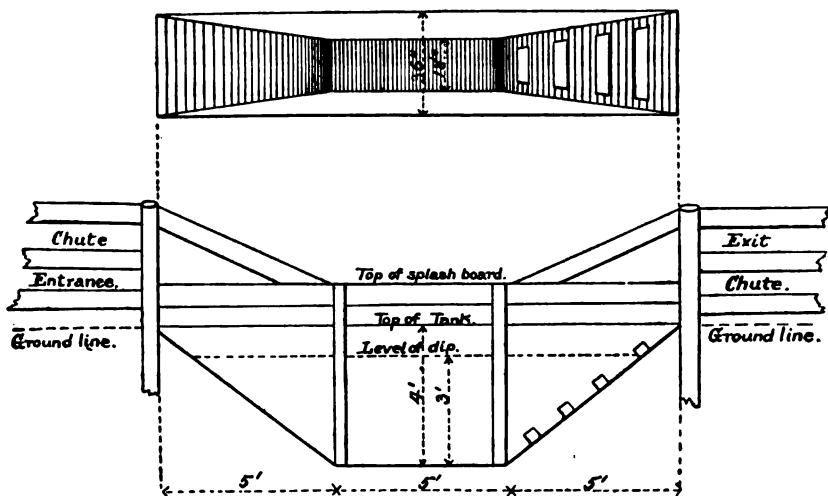


FIG. 10.—Plans for small "wade tank." Vertical section.

the end of the hoist rope to the saddle horn or the swingletree of a horse in harness. During the raising of the cage the animal drains, and after a short interval the opposite end gate is opened and the animal passes out. With this vat from 30 to 50 animals can be dipped per hour.

THE WADE TANK.

The wade tank is recommended only in the disinfection of very small herds. It can be constructed with an outlay of less than \$10 for materials, thus being cheaper than a good spray pump. Figure 10 shows plans of such a vat, which can be made of either lumber or cement.

In the use of this tank the animal is led in by a rope or halter and cross-tied or held. The solution in the vat, being 36 inches deep,

thoroughly saturates the lower parts of the body and sides, which are always most heavily infested and most difficult to reach with a spray pump or swab. The upper parts of the body are then thoroughly wet by pouring the dipping solution from a pail over the head and back. The animal is then led out at the opposite end of the vat and allowed to drain on the incline or in the chute. With this method less fluid is used than in spraying or swabbing, the operation is easier to perform, and it is efficacious.

PRESENT CONDITIONS IN CALIFORNIA.*

As a result of four years' work by the Bureau and state officials, California has only 9,315 square miles, instead of 69,755 square miles, of territory in quarantine for Texas-fever ticks. Of this area remaining in quarantine a large percentage is at present tick free and should soon be in a condition to be released.

Of the original 153,476 cattle infested there remain under local quarantine 41,906. This number includes all herds on which the slightest infestation has been found in 1910, and many of these will no doubt be free with the close of this season's work. Half of this number are on one large ranch where eradication work has been slow on account of its size, the roughness of the range, and lack of co-operation from the owner.

Prior to the inauguration of tick eradication in California condemnations for Texas fever were numerous in the abattoirs having federal inspection. During the past two years not a single condemnation for this disease has occurred in Los Angeles, where the majority of the cattle from the quarantined area are slaughtered. In the past year deaths from Texas fever on the ranges, where some years back losses annually reached into the thousands of head, have been so few as to be hardly worthy of notice. Our experience has proved that tick eradication is not only possible, but with stringent laws and proper methods is very practicable. When attained it returns to the individual owner and the cattle industry at large many times more than the cost of its accomplishment.

* Data brought down to summer of 1910.

636,013
U58
B95c

Issued March 17, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 175.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY
UNIV. OF MICH.
APR 24 1911

THE CONTROL OF BOVINE TUBERCULOSIS.

REPORT OF THE INTERNATIONAL COMMISSION
OF THE
AMERICAN VETERINARY MEDICAL ASSOCIATION,
SEPTEMBER, 1910.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., January 21, 1911.

SIR: I have the honor to transmit herewith the report of an international commission of the American Veterinary Medical Association on the control of bovine tuberculosis, which was presented at the annual meeting of the association at San Francisco in September, 1910. This report, formulated after thorough consideration of the subject by a well-constituted body of men combining scientific knowledge with practical views, forms a valuable contribution toward the solution of the animal tuberculosis problem, and should have great influence in stimulating and directing efforts for the suppression of this disease. To aid in giving publicity to the information and plans thus presented, I respectfully recommend the publication of the report as a circular of this bureau.

Very respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON.
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction.....	5
Report of the International Commission on the Control of Bovine Tuberculosis.....	7
RESOLUTION 1.—Dissemination.....	9
RESOLUTION 2.—Tuberculin test.....	10
RESOLUTION 3.—Evidence from tuberculin test.....	10
RESOLUTION 4.—Compulsory notification.....	10
RESOLUTION 5.—Location through slaughter.....	10
RESOLUTION 6.—Disposition of tuberculous animals.....	11
RESOLUTION 7.—Prevention.....	12
RESOLUTION 8.—Control of tuberculin test.....	12
RESOLUTION 9.—Education.....	12
RESOLUTION 10.—Publicity.....	13
RESOLUTION 11.—Legislation.....	13
RESOLUTION 12.—Sanitation.....	13
RESOLUTION 13.—Immunization.....	14
RESOLUTION 14.—Animal tuberculosis and public health.....	14
RESOLUTION 15.—General statement.....	14
Appendix:	
A. Report of Committee on Education and Legislation.....	17
Supplemental report by W. D. Hoard.....	18
B. Report of Committee on Location of Tuberculosis in Cattle.....	19
C. Report of Committee on Dissemination of Bovine Tuberculosis.....	22
D. Report of Committee on Disposition of Tuberculous Animals.....	23
E. The commission's recommendations on eradication.....	25

MEMBERS OF THE COMMISSION.

J. G. RUTHERFORD, V. S., H. A. R. C. V. S., veterinary director general and live stock commissioner of the Dominion of Canada, Ottawa, Canada; chairman.

M. H. REYNOLDS, D. V. M., professor of veterinary science, College of Agriculture and Experiment Station, University of Minnesota, St. Anthony Park, St. Paul, Minn.; secretary.

WILLIAM C. EDWARDS, Senator, Canadian Parliament, Ottawa, Canada.

J. J. FERGUSON, head of the animal foods branch, Swift & Co., Chicago, Ill.

J. W. FLAVELLE, LL. D., governor, University of Toronto; president William Davies Packing Co.; Toronto, Canada.

W. D. HOARD, ex-governor of Wisconsin; editor of "Hoard's Dairyman;" Fort Atkinson, Wis.

CHARLES A. HODGETTS, M. D., C. M., L. R. C. P., chief medical adviser, Committee on Conservation for Canada, Ottawa, Canada.

J. N. HURTY, M. D., secretary State Board of Health of Indiana, Indianapolis, Ind.

JOHN R. MOHLER, A. M., V. M. D., chief of the Pathological Division, Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

VERANUS A. MOORE, M. D., director of the New York State Veterinary College, Cornell University, Ithaca, N. Y.

MAZŸCK P. RAVENEL, M. D., professor of bacteriology, University of Wisconsin, Madison, Wis.

E. C. SCHROEDER, M. D. V., superintendent of Experiment Station, Bureau of Animal Industry, United States Department of Agriculture, Bethesda, Md.

T. W. TOMLINSON, secretary American National Live Stock Association, Denver, Colo.

FREDERICK TORRANCE, B. A., D. V. S., director of the faculty of comparative medicine, University of Manitoba, Winnipeg, Manitoba.

INTRODUCTION.

The greatest problem confronting the live-stock industry is the increasing prevalence of tuberculosis among cattle and hogs and the necessity of adopting measures for suppressing and controlling this disease. A careful estimate made by the writer for the International Congress on Tuberculosis in 1908 showed that tuberculosis of animals exacts a toll of over \$23,000,000 annually. Of even greater moment than this tremendous economic loss is the sacrifice of human life and the impairment of human health from tuberculosis, almost universally regarded by scientific investigators to be due in some considerable degree to the existence of tuberculosis in animals from which milk and other foods are derived.

No one who is informed on the subject can fail to realize that something should be done to check the rapid spread of tuberculosis among cattle and hogs and to control and eventually to eradicate the disease. As this disease in hogs is nearly always contracted from tuberculous cattle, it is believed that if bovine tuberculosis were suppressed swine tuberculosis would soon disappear; hence our main attack must be directed against the disease in cattle. Efforts have been made for some years to combat bovine tuberculosis, and while some headway has been made in some sections and localities, in general the disease has continued to spread, and on the whole it appears that the progress of the disease has been more rapid than the progress of the work against it. The time has come when something should be done in a more definite, systematic, and practical way and on a larger scale. However difficult may be the task of controlling and eradicating tuberculosis, the problem is constantly becoming more difficult as the infection becomes more widespread. It is much easier to deal now with a disease affecting on the whole about 5 per cent of our cattle than it will be to combat it later if we permit it to spread until it affects 40 or 50 per cent, as is the case in some parts of Europe.

Recognizing the gravity of the situation, the American Veterinary Medical Association at its annual meeting at Chicago in September, 1909, created an international commission to study methods of control of bovine tuberculosis, with instructions to submit a report at the next annual meeting. The commission as first appointed was as follows: Dr. J. G. Rutherford, Hon. W. C. Edwards, Mr. J. W. Flavell, Hon. W. D. Hoard, Dr. C. A. Hodgetts, Dr. John R. Mohler, Dr. V. A. Moore, Dr. Leonard Pearson, Dr. M. H. Reynolds,

Dr. E. C. Schroeder, Mr. Louis F. Swift, and Dr. Frederick Torrance. The commission first met at Buffalo, N. Y., December 13 and 14, 1909, and organized by electing Dr. Rutherford as chairman and Dr. Reynolds as secretary. Owing to the death of Dr. Pearson and the inability of Mr. Swift to serve, the writer, as president of the association, appointed in their places, respectively, Dr. M. P. Ravenel and Mr. T. W. Tomlinson. Later, at the request of the commission, he also appointed Mr. J. J. Ferguson as a representative of the United States packing industry and Dr. J. N. Hurty as a representative of the medical health officers of the United States. The final personnel of the commission is shown in the list on page 4.

The commission comprised in its membership not only veterinarians, but physicians and representatives of the stock-raising, meat-packing, and dairy interests—scientists, professional men, and practical men of affairs—five from Canada and nine from the United States. The body was thus exceedingly well qualified to consider the subject in a broad way and from the various points of view.

After four meetings of the commission and several conferences of subcommittees, and as a result of thorough consideration of the subject by the members, the commission presented its report at the annual meeting of the American Veterinary Medical Association at San Francisco in September, 1910. This report, which appears in the following pages, recommends and outlines definite plans and policies for the control of bovine tuberculosis. Besides stating important facts about the disease, it points out the necessity for education and legislation, describes methods for handling cattle by breeders and dairymen, and proposes administrative measures to be followed by public officers. It is believed that these recommendations are practical, and that they point the way to more effective warfare against this great common plague of animals and man.

A. D. MELVIN,

President American Veterinary Medical Association, 1909-10.

REPORT OF THE INTERNATIONAL COMMISSION ON THE CONTROL OF BOVINE TUBERCULOSIS.

TO THE PRESIDENT OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION :

Owing to the great economic and sanitary significance of animal tuberculosis to the live-stock industry of America and the many and varied factors which must of necessity be accounted with in formulating successful measures for its eradication, the American Veterinary Medical Association, at its meeting in Chicago in September, 1909, appointed the International Commission on the Control of Bovine Tuberculosis. The commission was instructed to study the problem of tuberculosis among cattle and to report at the next meeting of the association upon reasonable and economically practicable methods or systems to be recommended to both officials and live-stock owners for eradicating this great scourge of domesticated animals.

It is recognized that tuberculosis is widely prevalent among cattle and other animals, and that the frequency with which this great evil occurs is increasing rather than declining. As tuberculosis is one of the strictly preventable infections, there is good ground for the belief that through the formulation and enforcement of proper regulations the disease may eventually be entirely suppressed.

The commission has held four meetings, as follows: Buffalo, N. Y., December 13 and 14, 1909; Detroit, Mich., March 1 and 2, 1910; Ottawa, Canada, May 19, 20, and 21, 1910; Madison, Wis., June 27 and 28, 1910; all of which were well attended, very few of the members having on any occasion been absent. The commission begs to present as a result of its labors the following report, which, although brief, will on examination be found to comprise the principal points essential to the promulgation of a comprehensive and practical policy, such as may reasonably be adopted by any governmental body interested in the control of bovine tuberculosis.

It is quite unnecessary, in view of the extensive knowledge already possessed by all who are familiar with the efforts which have hitherto been made to secure control of bovine tuberculosis, to dwell at any length upon the importance of the subject or upon the conditions which led to the formation of the commission.

In view of the personnel of the commission as selected by the American Veterinary Medical Association, and of the fact that so much information on the subject has been made available through the work of similar bodies in other countries and the researches of scientific and practical men in America and elsewhere, the commission has not deemed it necessary to take any evidence either from expert witnesses or others.

The members fully understood that the purpose which their appointment was intended to serve was less the acquisition of new knowledge regarding bovine tuberculosis than the careful study of the knowledge already available and of the thoughts and opinions of those most entitled to speak with authority on the subject.

The conclusions reached in this report are therefore simply the outcome of an earnest and thoughtful consideration of the various modern aspects and phases of the problem, with the object of crystallizing public opinion and so clearing the way for legislative action. They realized also that they could deal with fundamental principles only, and that the details of any policy which they might outline must in each case be worked out by the duly authorized and responsible representatives of the community immediately concerned. They nevertheless deemed it essential to study closely the history of the various efforts hitherto made by such countries throughout the world as have attempted to legislate on the subject. This naturally led to the gradual elimination of all methods other than such as might reasonably be adopted by any community desiring, in the full light of present-day knowledge, to undertake the control of bovine tuberculosis.

It was felt, in view of the prevalence of the disease, especially in some localities and among certain classes of cattle, the difficulty of providing a sufficient number of trained officials, and the large economic questions involved, to say nothing of the enormous expenditure, that it would be unwise, for the present at least, to discuss seriously a policy of universal compulsory testing and slaughter. Such a policy might perhaps be adopted with advantage by a small community, or one in which the disease existed to a very limited extent; but speaking generally, especially in view of past experiences in this line, it was thought better to omit it entirely from the recommendations of the commission.

All other methods of dealing with bovine tuberculosis which have been recommended or tried in various communities were thoroughly discussed, with the object of discarding weak points and adopting such features as might be deemed worthy of a place in the official findings of the commission. Every phase of the subject was in this way fully and freely considered. it being thought best to cover the

whole ground as completely as possible before coming to a definite decision on any one point. In order to minimize still further the risk of omitting from the deliberations of the commission any phase of the question, four committees were appointed at the first meeting to deal respectively with—

1. Education and legislation.
2. Location of tuberculosis.
3. Dissemination.
4. Disposition of tuberculous animals.

The appointment of these committees proved to be of the greatest possible value in concentrating the energies of the various members on those branches of the subject with which they were most familiar, and their reports presented at subsequent meetings enabled the commission to reach satisfactory conclusions much more rapidly than would otherwise have been the case. As a means of furnishing information as to the reasons for these conclusions and the manner in which they were reached, the commission would recommend that the reports of the committees should be published as an appendix to this report.

The commission, recognizing after careful study that the tuberculin test is the fundamental factor in any policy having for its object the control of bovine tuberculosis, decided that a pronouncement to that effect should properly occupy a foremost place.

Based on the information contained in the reports of its committees and on such other information as was brought out in the general discussions of the commission, the following resolutions were adopted for presentation to the American Veterinary Medical Association:

RESOLUTION 1.—DISSEMINATION.

As a general policy to be observed, all contact between tuberculous and healthy cattle and between healthy cattle and stables, cars, etc., which may contain living tubercle bacilli should be prevented. To accomplish this the following specific recommendations are made:

1. There should be no sale or exchange of animals affected with tuberculosis except for immediate slaughter or for breeding purposes under official supervision.
2. That the management of live-stock shows should give preference to cattle known to be free from tuberculosis, either by providing special classes for such cattle or in some other practical way, and should also take every precaution to prevent contact between such animals and those not known to be free from disease.
3. All live-stock shippers should take every precaution to see that cars furnished are thoroughly cleansed and disinfected before use.

RESOLUTION 2.—TUBERCULIN TEST.

1. That tuberculin, properly used, is an accurate and reliable diagnostic agent for the detection of active tuberculosis.

2. That tuberculin may not produce a reaction under the following conditions:

- (a) When the disease is in a period of incubation.
- (b) When the progress of the disease is arrested.
- (c) When the disease is extensively generalized.

The last condition is relatively rare and may usually be detected by physical examination.

3. On account of the period of incubation and the fact that arrested cases may sooner or later become active, all exposed animals should be retested at intervals of six months to one year.

4. That the tuberculin test should not be applied to any animal having a temperature higher than normal.

5. That any animal having given one distinct reaction to tuberculin should thereafter be regarded as tuberculous.

6. That the subcutaneous injection of tuberculin is the only method of using tuberculin for the detection of tuberculosis in cattle which can be recommended at the present time.

7. That tuberculin has no injurious effect on healthy cattle.

RESOLUTION 3.—EVIDENCE FROM TUBERCULIN TEST.

That a positive reaction to tuberculin in any properly conducted test, official or otherwise, in any animal in any herd shall be considered evidence sufficient upon which to declare the herd to be infected.

RESOLUTION 4.—COMPULSORY NOTIFICATION.

That this commission recommends the passage of legislation providing for the compulsory notification by owners and by veterinarians of the existence of tuberculosis in a herd, whether such existence be made known by detection of clinical cases or by the tuberculin test.

RESOLUTION 5.—LOCATION THROUGH SLAUGHTER.

This commission recognizes that the discovery of tuberculosis in animals slaughtered for food purposes furnishes one of the best possible means of locating the disease on the farm, and therefore recommends the adoption of some system of marking, for purposes of identification, all cattle 3 years old and over, shipped for slaughter.

As tuberculosis of hogs is almost invariably due to bovine infection, this recommendation should also be made to apply to hogs of any age shipped for slaughter.

It is further recommended that the discovery of tuberculosis in animals coming under Government inspection should be used, whenever

identification is possible, as a means of locating infected herds and premises. All such cases should be reported to the proper authorities for control action.

RESOLUTION 6.—DISPOSITION OF TUBERCULOUS ANIMALS.

THE COMMISSION PLAN.

1. As a general policy in the eradication of tuberculosis the separation of healthy and diseased animals and the construction of a healthy herd are recommended. In order to accomplish this the following recommendations are made:

(1) If the herd is found to be extensively infected, as shown by the tuberculin test or clinical examination, even the apparently healthy animals in it should be regarded with suspicion until they have been separated from the reacting animals for at least three months. If after the expiration of this time they do not react to the tuberculin test, they may be considered healthy and dealt with accordingly.

It is recommended that a herd extensively infected should not be treated by the method of general separation, but that the construction of a new herd from the offspring only is advisable.

(2) If the herd is found by either or both of the above methods to contain a relatively small proportion of diseased animals, separation of the diseased animals from the healthy animals and the construction of a sound herd from the healthy animals and the offspring of both are advocated.

As a working basis in carrying out these principles, we advise:

(a) That herds containing 50 per cent or more of diseased animals be treated as coming under section (1).

(b) That herds containing under 15 per cent of diseased animals be treated as coming under section (2).

(c) That herds falling between these figures be graded according to the option of the owner.

(d) That it shall be the prerogative of the owner to reject either plan and have his herd dealt with by removal and slaughter of diseased animals, with or without compensation, according to the public policy in operation.

2. That when by any means the officials properly charged with the control of tuberculosis become aware of its existence in a herd to which a policy of slaughter and compensation can not reasonably be applied, such herd must be dealt with by the owner, under Government supervision, on the principle of the separation of all sound animals from those affected. Such separation must be effected by treating the whole herd as diseased, and rearing the calves separately, either on pasteurized milk or the milk of healthy cows, or, when the number of those affected is so small as to warrant such a course, by

the application to the whole herd, from time to time, under official supervision, of the tuberculin test, and the entire segregation of all animals found to react. In the event of any owner refusing or neglecting to adopt either of the above methods, his entire herd to be closely quarantined and sales therefrom to be entirely prohibited.

3. That a policy of compensation be recommended as useful and usually necessary as a temporary measure.

4. That when slaughter is necessary, in order to avoid economic loss, every effort should be made to utilize as far as possible the meat of such animals as may be found fit for food on being slaughtered under competent inspection.

5. The details of the commission plan will be found fully set forth in the appendix to this report.

RESOLUTION 7.—PREVENTION.

1. That with the object of preventing the spread of infection persons buying cattle for breeding purposes or milk production should, except when such purchases are made from disease-free herds which have been tested by a properly qualified person, purchase only subject to the tuberculin test. In order to assist in the proper carrying out of this suggestion, the commission recommends that official authorities should adopt such regulations as will prevent the entry to their respective territories of cattle for breeding purposes or milk production unless accompanied by satisfactory tuberculin test charts.

2. That all milk and milk by-products used as food should be properly pasteurized unless from cows known to be free from tuberculosis.

RESOLUTION 8.—CONTROL OF TUBERCULIN TEST.

That this commission recommends the passage of legislation which will prevent the sale, distribution, or use of tuberculin by any person other than those acting with the full knowledge or under the direction of official authorities.

RESOLUTION 9.—EDUCATION.

As a clear knowledge of the cause and character of tuberculosis among animals, the modes of dissemination, and its significance as an economic and as a public-health problem underlie an intelligent adherence to the principles that must be observed in all efforts for eradication, as well as the establishment of proper cooperation in the great work between physicians, veterinarians, live-stock owners, legislators, and the public generally, it is recommended that a widespread campaign of education be undertaken. To accomplish this end it is recommended that, first of all, a simple pamphlet on bovine tuberculosis be written, in which the language used shall be of such character

that every person of average intelligence shall be able to read it without being mystified by technical terms or phrases. This pamphlet should be published with the indorsement of the American Veterinary Medical Association and the special indorsement and consequent authority of the International Commission on Bovine Tuberculosis Control.

RESOLUTION 10.—PUBLICITY.

In concluding its work, the commission desires to appeal especially to the press—metropolitan, agricultural, and local—to join in the work of extending as much as possible among the people the conclusions here arrived at. The vital importance of the life of farm animals to the welfare of all classes of society needs no argument in its support. The aim and sole purpose which has actuated this commission has been to arrive at the soundest conclusions possible in the light of the best knowledge obtainable.

RESOLUTION 11.—LEGISLATION.

It is recommended that legislation regarding the control and eradication of tuberculosis among domestic animals be made uniform; that the laws of the United States and Canada and other American countries for the admission into America of animals from without be made stringent and as much alike as possible; and that the laws governing the interstate and interprovincial movement of cattle and that between different American countries be harmonized.

The laws governing interstate and interprovincial movement of cattle should be of such character that every State and every province will be free in its eradication work from unnecessary difficulties due to the existence of the disease in other States and provinces.

Legislation is especially required to prevent the various frauds which interfere with the satisfactory use of tuberculin as a diagnostic agent for tuberculosis, as well as for official supervision over all tuberculin sold to be used by veterinarians and others.

RESOLUTION 12.—SANITATION.

In the eradication of tuberculosis it should be kept in mind that, in addition to protecting animals against exposure to tubercle bacilli, it is desirable to make them as resistant to infection as possible. This can be done by stabling them in clean, disinfected, and properly ventilated and lighted barns, giving them abundant clean water and nutritious food, a sufficient amount of daily exercise in the open air, and attending generally to those conditions which are well known to contribute to the health of animals.

The daily removal of manure from stables, and water-tight floors and good drainage in stables are urgently recommended.

Young stock, particularly, should be raised as hardy as possible and should be accustomed to liberal exercise and living in the open.

RESOLUTION 13.—IMMUNIZATION.

That as none of the various methods for the immunization of animals against tuberculosis have passed sufficiently beyond the experimental stage, the commission is unable to indorse any of these for practical use at the present time.

RESOLUTION 14.—ANIMAL TUBERCULOSIS AND PUBLIC HEALTH.

While the members recognize that the subject with which this commission is primarily intended to deal is the control and eradication of tuberculosis among animals as an economic problem, they can not feel satisfied without declaring their recognition of the fact that tuberculosis among animals is also an important public-health problem. Considered as such, the eradication of tuberculosis among animals should have the approval and support of all those persons who are interested in curtailing human suffering and prolonging human life.

RESOLUTION 15.—GENERAL STATEMENT.

The members of the commission wish to be clearly understood that they recognize the limitations of a report necessarily based on actual and not on theoretical conditions. They fully realize that in the event of the policy of which their recommendations form the framework being anywhere adopted even in its entirety, much greater benefit will be derived, at least for some time, from its educative than from its executive features. The control, to say nothing of the eradication, of bovine tuberculosis, is impossible of achievement without the hearty cooperation of all the men who are actually engaged in the cattle industry. In order to secure this cooperation, it will doubtless be necessary in most communities to carry on an active and prolonged educational campaign.

It is apparent that in the dissemination of practical and reliable information regarding the disease it will be possible to employ a very large variety of methods. Many of these methods, such as bulletins, lectures, and actual demonstrations of disease, having already been found valuable, will doubtless continue to be largely used. It must not be forgotten, however, that in this, as in any other educative process, a measure of disciplinary control is essential to success. Needless to say, such control can be secured only by the passage of legislation which, while clear and comprehensive, must at the same time be sufficiently conservative to avoid exciting alarm or arousing antagonism on the part of owners, especially of valuable herds. The

best law ever framed can be made an utter failure by stupid or injurious administration, while, on the other hand, the most drastic legislation can be rendered acceptable if enforced with reasonable tact and diplomacy. Provided, therefore, that these qualities, combined with integrity, thoroughness, and determination, are available for administrative purposes, the members of the commission are convinced that the enforcement of a law based on their recommendations will prove to be by far the most powerful and effective educational agency which could possibly be employed.

In concluding its report the commission would suggest that the association should make such provision as may be necessary to carry on the work either by continuing the commission as at present constituted or with such changes in the personnel as may be considered desirable.

WM. C. EDWARDS.

J. N. HURTY.

E. C. SCHROEDER.

J. J. FERGUSON.

J. R. MOHLER.

T. W. TOMLINSON.

J. W. FLAVELLE.

V. A. MOORE.

F. TORRANCE.

W. D. HOARD.

MAZŮCK P. RAVENEL.

CHAS. A. HODGETTS.

J. G. RUTHERFORD, *Chairman*.

M. H. REYNOLDS, *Secretary*.

APPENDIX.

A. REPORT OF COMMITTEE ON EDUCATION AND LEGISLATION.

The subcommittee on education respectfully submits the following:

Bovine tuberculosis has become widely distributed throughout the United States and Canada, and it has been determined that efficient systems or methods for its eradication and prevention, either under the supervision of the State or Nation or by the cattle owners themselves, are of necessity based on a knowledge of the nature of the disease and its means of dissemination.

Experience has shown that the principles of eradication and prevention may be successfully applied by individual owners of infected cattle, independent of state assistance. Such individual aid is essential in conjunction with state or national assistance in the prompt eradication of the disease from infected herds and the prevention of its entry to noninfected herds.

Therefore it is the sense of this committee that every possible means should be employed for educating the cattle owners and the general public concerning the nature of tuberculosis, the care and precautions necessary to prevent its entrance into herds already free from the disease, and in methods for its eradication from herds where it now exists.

Further, this committee approves of the following methods for instructing laymen, practicing veterinarians, practitioners of human medicine, and health officers in the nature and control of bovine tuberculosis, namely:

1. By the publication in agricultural and dairy papers of short, accurately and carefully prepared articles on bovine tuberculosis.
2. By publication of appropriate articles on bovine tuberculosis in veterinary, medical, and sanitary papers and journals.
3. By recommending to agricultural societies, granges, and directors of farmers' institutes and unions, and especially those interested in creameries and cheese factories, that lectures on bovine tuberculosis, its nature and control, be made a part of their programs, and that so far as practicable demonstrations be held.
4. That those having in charge the arrangement of town, county, and State fairs be requested to provide lectures on bovine tuberculosis, and if practicable to hold public demonstrations, at their annual meetings.
5. By placing a copy of the report of the commission in the hands of the deans or directors of all veterinary and medical colleges and schools of sanitary science in the United States and Canada, with recommendations that special emphasis be placed in their courses of instruction on the nature of bovine tuberculosis and methods for its control.
6. That a pamphlet dealing with the nature of bovine tuberculosis and methods for its control should be written in language intelligible to the layman. This pamphlet should have the approval of this commission and the indorse-

ment of the American Veterinary Medical Association. It should be published for free distribution.

7. That departments of agriculture, State veterinarians, live-stock sanitary boards, and others interested in the official control of bovine tuberculosis be requested to promote as much as possible the educational features of their work, with the object of obtaining more support and cooperation from cattle owners.

The methods suggested for carrying out an educational propaganda are not to be considered at the exclusion of any and all other ways by which the public may become informed on the nature of bovine tuberculosis, its great economic importance, and the necessity for an intelligent and united effort on the part of cattle owners and those having charge of the control of animal diseases to eradicate this great scourge.

The committee is of the opinion, from the history of the legislation regarding bovine tuberculosis in those States and counties which have attempted to deal radically with the problem, as well as from the special information which has been furnished by this committee to its members, and the light thrown upon the subject in the discussions at its several meetings, that in order to avoid friction and failure all important legislation with reference to tuberculosis must be prepared with due consideration for the condition of public sentiment and information on this subject; that tuberculosis-control work should be developed in a progressive way; that tuberculin tests made at a distance for public recognition (for example, in other States or foreign countries) can only be done satisfactorily by official veterinarians; that the Delepine or Manchester plan of tuberculosis-free areas gradually extended seems worthy of cautious trial.

M. H. REYNOLDS, *Chairman.*
W. D. HOARD.
J. G. RUTHERFORD.

SUPPLEMENTAL REPORT BY W. D. HOARD.

MR. PRESIDENT AND GENTLEMEN OF THE COMMISSION:

I place a high value on the work this commission may do if performed wisely, in shaping the conviction and purpose of the people of Canada and the United States concerning the prevention and control of bovine tuberculosis.

As yet that conviction is but little more than an ill-defined dread of something not clearly understood by the great mass of farmers. Added to this dread is a hope stronger yet that the evil is not as great as has been asserted; that it is a scare that will soon pass over. As yet in the minds of farmers and breeders generally, especially in those localities where demonstration work has not been had, there is a strong undercurrent of conviction that all this talk about the disease is an interested plea of the veterinarians, that the trouble does not amount to much if the doctors and editors would hold their tongues and pens. Just as long as this bank of fog exists it will control all legislation and individual effort to get rid of the difficulty. At the bottom of the matter is a widespread ignorance on the part of farmers as to the danger that threatens them; it is difficult to arouse them out of their conservatism, for as yet all they know about it is talk. The conservatism of intelligence is vastly different from that which exists because of a lack of knowledge. The first demands more light, the latter dreads light.

From what I have seen in Wisconsin I am convinced that the most powerful aid to that action against the disease which this commission is so anxious to bring about is public demonstration. One animal slaughtered before a body of farmers, and the diseased parts exposed to their plain view, is worth more to foster conviction and inspire effort than anything else that can be done. If the Federal and State governments would devote means for this demonstration work it would prove a most powerful educator. Public agitation in farmers' gatherings and the talk of the agricultural press is useful mainly in keeping alive an interest in the subject. But we must remember that with the majority of men—a large majority—"seeing is believing."

I believe, therefore, that this commission should use its influence in urging legislation by municipalities and state and national legislatures for the spread and support of this demonstration work. Great care must be exercised, however, to select only such animals as will amply show forth the ravages of the disease. The great progress we have made in legislation in Wisconsin and in securing widespread acquiescence in the use of the tuberculin test would never have come had it not been for a large number of public demonstrations held in various parts of the State.

We have gone as far as this in legislation: After December 1, 1910, all animals sold for breeding or milking purposes must first be tuberculin tested. This, I believe, is a step further in advance than has been taken by any other State. It shows well the tone and temper of our farmers and the work which has been done to acquaint them with a true understanding of the situation. It is needless for me to say that if they are for the law, or any law, it goes; if they are against it, it is at best a dead letter. It is worth a great deal in the promotion of such objects to have a live-stock sanitary board in a State that will take hold and lead in this work. In too many instances these organizations are purely negative in their influence, and so nothing is done. There is a notable lack of funds to bear the expense of demonstration work. The farmers everywhere would willingly be taxed for its support. Municipalities could well afford to have such expense for the sake of the education it would afford to consumers of meat and dairy products.

In conclusion, I would urge upon this commission that special emphasis be placed upon the promotion of public exhibitions of diseased cattle before and after slaughter, as the most powerful means of education concerning the nature and danger of bovine tuberculosis.

W. D. HOARD.

B. REPORT OF COMMITTEE ON LOCATION OF TUBERCULOSIS IN CATTLE.

Your committee on the location of tuberculosis in cattle desires to submit the following as its report upon this subject.

Though we are all agreed that no method for detecting tuberculosis in cattle equals the tuberculin test, we are forced to recognize that the universal application of the test under existing conditions is practically and economically impossible. The number of cattle to be tested, for example, is so great that if all the available veterinarians and all such other persons as may be trusted to make tuberculin tests should be started on this work at once and kept at it, years would pass before all the cattle in the United States and Canada could be tested even a single time. Consequently our efforts to locate tuberculosis among cattle should depend primarily upon other means than the tuberculin

test. The tuberculin test should be regarded as having only an incidental value in the systematic work of locating tuberculosis, and as being of preeminent importance when we undertake the determination of the extent to which the disease is prevalent at any point in any herd where it has been located by other means or incidentally by the tuberculin test.

In the order of seeming importance the means of location may be placed as follows:

I. NOTIFICATION.

A law should be enacted requiring any and every person having knowledge of the existence of a case of tuberculosis among cattle to report the same without delay to some proper designated authority. Such a law would be practically equivalent to the obligatory reporting of all clinical cases of tuberculosis, which must be recognized as the most serious disseminators of tubercle bacilli and propagators of tuberculosis. Since all cases of tuberculosis that are centers from which infection is being scattered gradually become clinically recognizable, obligatory notification of all recognized cases of tuberculosis would alone in the course of a few years locate the majority if not all badly diseased herds. It would certainly locate tuberculous cattle and herds faster than they can be handled for some years to come.

II. EVIDENCE THROUGH MEAT INSPECTION.

An effort should be made to trace tuberculous animals back from slaughterhouses to the farms from which they were derived. This is important, because if the well-conditioned animals which go to slaughter for meat are tuberculous it is probable that among the animals retained on the farm some active disseminators of tubercle bacilli exist, which are retained at the farm either through ignorance or a false idea of economy.

Meat inspection has already done much to establish infected areas from which tuberculous animals have been sent to market. At present, however, it is difficult to trace animals to the farms from which they were shipped, and some method of identification by means of which any animal found on the killing floor to be tuberculous can be traced to its place of origin is greatly to be desired. A Federal law requiring appropriate tagging, branding, or otherwise identifying all hogs and dairy cattle moving interstate for slaughter, and state laws compelling similar identity marks for these animals moving within the State for slaughter, would be the means of locating a large proportion of the centers of tuberculosis. Experimental work of this character which has been carried out in the past has given very interesting results. For instance, when the occurrence of tuberculosis among hogs at an abattoir is followed up by a tuberculin test of the cattle on the home farm it practically always discloses tuberculosis among these animals. Like much other evidence, this encourages us to believe that tuberculosis among hogs will cease to exist as an economically important problem as soon as we succeed in controlling the bovine source of tubercle bacilli.

III. THE TUBERCULIN TEST.

When the tuberculin test is applied to cattle for any purpose it should be clearly understood that the reacting animals are to be regarded in every sense of the word as recognized cases of tuberculosis which under an obligatory notification law must be reported at once to the proper authority. In this way

tuberculin will serve as an important means of locating tuberculosis among cattle that are tested for reasons like the following :

1. To obtain healthy animals for export.
2. To make sure that animals imported are free from tuberculosis.
3. To make sure that animals intended for interstate movement are free from tuberculosis. And here we would like to suggest that the States should protect themselves as much as possible against bovine tuberculosis by insisting that no new cattle shall be brought in until they have been shown by the tuberculin test to be free from tuberculosis. The time, we may hope, is not far off when even breeders of exceptionally fine strains of blood will begin to realize that the very best blood coupled with tuberculous infection is an article to be shunned, not because we wish to imply that tuberculosis is hereditary, but because we know how readily it is conveyed from animal to animal by contact.
4. To obtain milk from animals shown in the most conclusive manner to be free from tuberculosis, irrespective of whether the milk is intended for special certification or for more general or regular city use.
5. To satisfy an owner of cattle that his herd is free from tuberculosis, or to give him the information he needs to clean his herd from disease.

In whatever way the tuberculin test is applied, or for whatever purpose, all positive reactions obtained should be regarded as placing the reacting animal in the category of recognized cases of tuberculosis, which must be reported under a notification law.

As the newer methods of applying tuberculin for test purposes have not been found to be as reliable as the older subcutaneous method, they can not be advocated. The ophthalmic and cutaneous tuberculin tests may have a value in some special cases, as, for example, where doubt exists about the reliability of a subcutaneous test because an animal may have been subjected to some pernicious manipulation. In this sense these later modes of applying tuberculin should be kept in mind.

IV. EXAMINATION OF MATERIAL FROM CATTLE AND HERDS.

The valuable evidence that may be obtained as to the location of tuberculosis through the examination of milk, cream, butter, centrifuge slime, and other products and materials from cattle should not be neglected, especially when these examinations are made by health officers and others for the protection of public health and are followed up by the inspection of the animals and of the character of their environment as a routine procedure. Such inspections are constantly becoming more prevalent in various sections of the United States and Canada.

V. MOST IMPORTANT SOURCES OF ANIMAL TUBERCULOSIS.

Tuberculosis as it exists among the domestic animals of America to-day undoubtedly owes its primary introduction to the cattle of improved breeding that have been imported from European lands from time to time in the past for the purpose of improving the native stock of the country. No particular breed is to be incriminated in this charge, as several of the most prominent and popular breeds have been found guilty of furnishing tuberculous individuals to the best American herds on repeated occasions. The knowledge that infection has taken place from these sources in the past affords us a valuable indicator of the points where search should be made in our efforts to detect the cases of tuberculosis that exist to-day upon the farms of the country. First of all, then, attention may be directed toward all herds of pure-

bred cattle, whether of beef or dairy type, especially to those from which cattle are sold either by private or public sale, and from which cattle are thus distributed to various parts of the country; also to herds from which members are exhibited at fairs and exhibitions, and herds which keep males for custom service.

In addition to these herds of pure-bred cattle, there are many others to which well-bred stock has been added for the purpose of grading up and improving the quality of the individuals of the herd.

These in some instances have received the infection of tuberculosis with the new animals from which such great benefits had been expected, and these herds of well-graded cattle should also be regarded with suspicion until they have been proved to be free of tuberculosis. Next in order should come all dairy cattle, but the methods by which the disease may be located in these herds has been discussed above.

JOHN R. MOHLER, *Chairman*.
J. W. FLAVELLE.
C. A. HODGETTS.

C. REPORT OF COMMITTEE ON DISSEMINATION OF BOVINE TUBERCULOSIS.

The subcommittee on the dissemination of bovine tuberculosis respectfully submits the appended report on the means for the dissemination of this disease, based on the present knowledge of the life history of the tubercle bacilli. The possible means for the dissemination of this disease are enumerated as follows:

1. The introduction into a sound herd of an animal or animals affected with tuberculosis of (a) those with open tuberculosis, (b) those in which the disease is in a period of incubation, and (c) those in which the lesions are temporarily arrested.

The last group will not transmit the infection speedily, and possibly may never do so. The first group is certain to spread the virus.

2. By feeding calves milk, whole or separated, buttermilk, or whey, where the milk has come from tuberculous cows.

3. By bringing cattle suffering from open tuberculosis into contact with healthy ones at fairs, cattle shows, and other exhibitions.

4. By shipping healthy cattle in cars not thoroughly disinfected, recently occupied by tuberculous cattle.

5. By placing healthy cattle in stables that have not been thoroughly disinfected and which were recently occupied by tuberculous animals, as frequently happens with the change of farm ownership or tenants.

6. Tuberculous animals which do not react to tuberculin, such as those in the period of incubation or latent cases, but which develop active tuberculosis later, are frequently carriers of the virus, although bought and sold as sound animals. These can not at present be differentiated from sound animals. Therefore all cattle coming from herds in which the disease exists should be considered as suspicious. The sound herd is the unit to deal with.

7. Tubercle bacilli may be transmitted by tuberculous cattle running in a pasture to healthy cattle in adjoining pastures where they are separated by a fence of such nature that the cattle may get their noses together.

8. Tuberculosis in cattle rarely, if ever, occurs through infection from (a) man, either directly or as a carrier of bovine tubercle bacilli, (b) from other species of animals, or (c) by infection from the droppings of crows, buzzards,

or other birds or carnivorous animals that have fed upon the carcasses of tuberculous cattle.

It is the opinion of this committee that bovine tuberculosis is spread largely through the introduction of tuberculous cattle into sound herds, by the feeding of calves with infected milk or milk products, by exposing sound animals to infected ones at fairs or other cattle shows, and by exposing them to infected cars and stables. There are other ways in which now and then it is possible that an animal may become infected, but the means of dissemination mentioned in this paragraph are those to be guarded against in formulating efficient methods of control.

V. A. MOORE, *Chairman.*

E. C. SCHROEDER.

M. P. RAVENEL.

D. REPORT OF COMMITTEE ON DISPOSITION OF TUBERCULOUS ANIMALS.

Your committee on the disposition of tuberculous animals begs to submit the following report:

In the work of control and eradication of tuberculosis in animals it is, first of all, of the utmost importance to establish the presence of the disease in all the affected cattle, since only by such a procedure will it be possible to guard the healthy and newly born animals from infection.

Fortunately we are in a position to determine with considerable certainty the vast majority of occult cases of tuberculosis in cattle, even the incipient cases, with the aid of tuberculin, and the clinical cases by physical examination. This alone constitutes a great advantage in the work of suppression of the disease. The tuberculin test should therefore be considered as a very important step in the eradication of tuberculosis. As a matter of fact, all the recognized authorities on the subject are agreed on this point.

Once the tuberculous animals are recognized, consideration must be given to the most suitable and economical way of eradicating the disease from the herd. This naturally brings up the question of the disposition of the tuberculous animals, and in adopting any particular method one should be guided by the extent of the infection of the herd, the quality of the affected animals, the sanitary condition of the premises, and, last but not least, the owner's intelligence and knowledge of the subject. The latter information is necessary to determine if reliance can be placed on the owner to carry out minutely all the details which are essential in executing any particular method of eradication that may be decided upon.

The owner's cooperation in this work is without doubt a very essential feature of this great task. For this reason a campaign of education of the farmers and stock raisers relative to the control of tuberculosis, in which all the advantages of the eradication of tuberculosis must be impressed on them, would greatly facilitate this important campaign. It is a well-known fact that any voluntary method of suppression by the herd owners themselves would bring about better and quicker results than when compulsory measures are enforced upon them by legislative enactments. Nevertheless, the time has arrived when a campaign looking toward the control of this disease should be entered upon by the General Government as well as the State and the Province. This campaign must reach in the first place all the clinical pulmonary forms of tuberculosis; then tuberculosis of the udder, intestines, and uterus.

Having removed these exceedingly dangerous cases, the balance of the tuberculous herd may be treated by the Bang system, which consists in the establishment of two herds of cattle, one containing the animals which reacted to tuberculin and the other those that proved to be healthy. Each class of cattle is kept entirely separate from the other, in different stables when possible, and under the care of separate attendants, using separate utensils. The calves born of diseased cows are removed from their mothers at birth and placed in the stable with the healthy animals, where they are reared upon the milk of healthy cows or upon other milk which has been properly pasteurized. In this way the healthy portion of the herd constantly increases, while the diseased animals are disposed of as rapidly as may be deemed necessary, until finally all of them are gone and the remaining herd is composed entirely of healthy cattle. The tuberculin test is applied to the healthy herd at regular intervals, annually or semiannually, in order to detect any cases of latent tuberculosis or recent infection which may appear.

A modification of the Bang system is Ostertag's method of suppressing tuberculosis. This system demands only a clinical examination of the original herd, with the elimination of all open cases of tuberculosis. The calves from the remaining cows are immediately removed and brought up on pasteurized milk in the same manner as in the Bang system, and a new herd is thus established from the young stock. Healthy nurse cows could be used for these calves instead of feeding them on pasteurized milk. The tuberculin test is applied to this new herd at stated intervals in order that any cases of tuberculosis which may develop therein may be discovered promptly.

Neither of these systems, however, has met with much favor in this country, as it requires a considerable length of time and care to create a herd free from tuberculosis by either of them. Nevertheless the inauguration of Bang's or Ostertag's method in herds of valuable animals, whether they be dairy or beef breeds, is unquestionably of an economic value, and in such cases either of these systems should be encouraged. On the other hand, in ordinary beef or dairy herds the practice of Bang's or Ostertag's method in this country has not met with much encouragement, owing to the extraordinary supervision, time, and labor, as well as the loss of market milk from the reacting cows, which it involves.

In such herds the best ultimate results have thus far been obtained by the obligatory disposal of all the clinically affected cows, and giving the dairyman the alternative either to pasteurize the milk from the remainder of his herd or to be forced to refrain from selling the raw milk from the infected herd at all. In case he adopts the former method, the herd composed of diseased and healthy cattle should be placed in quarantine under the supervision of sanitary authorities, and no sales should be permitted from the herd excepting for immediate slaughter. The alternative method will compel him to dispose of his tuberculous animals in the case he refuses to pasteurize the milk.

The suppression of tuberculosis could be greatly facilitated and the co-operation of many of the herd owners could be gained by a provision by which a certain percentage of indemnity could, at least for a term of years, be paid for the condemned animals. The scale for such an indemnity should be arranged in accordance with the final disposition of the carcass under competent inspection.

Another method of eradication should receive serious consideration as being of value in some localities. This is known as the Manchester system, which is either the Ostertag or Bang system applied to localized areas or even individual farms, from which centers the work progresses to surrounding or neighboring districts and farms.

Inasmuch as the animals affected with clinical tuberculosis are the greatest sources of danger in the dissemination of the disease, compulsory reporting of such cases should be inaugurated by the State, as is now done in many places in the control of human tuberculosis. Mandatory reporting of these cases and their prompt slaughter are very essential, as only by the elimination of these exceptionally dangerous cases can it be hoped to take up all the other details by which a successful control of bovine tuberculosis may be accomplished.

In conclusion your committee, having regard to the disposition of purebred cattle, or valuable animals kept for either breeding or dairy purposes, would strongly recommend a system requiring the removal of all clinically tuberculous animals from the herd, the segregation of all calves from the remaining cows in order to establish a new clean herd, the use of tuberculin-tested nurse cows or pasteurized milk for these calves, and the periodic application of tuberculin to this newly established herd, as the only thoroughly reliable one.

W. C. EDWARDS, *Chairman.*

JOHN R. MOHLER.

FREDERICK TORRANCE.

E. THE COMMISSION'S RECOMMENDATIONS ON ERADICATION—A COMPOSITE OF THE METHODS OF BANG AND OTHERS.

The commission, after stating the known facts regarding the nature of tuberculosis and enumerating the principles to be observed in its prevention and eradication, recommends the following plan of procedure. It is recognized that in several points there are opportunities, in order to meet individual needs, to change or modify the directions herein given. It is understood, however, that whenever such modifications are made they should conform in the greatest detail to the principles laid down in the report of this commission. The plan has for its purpose the conservation of the herd whenever that is possible.

The control of bovine tuberculosis involves a definite procedure under two distinct and different conditions, namely, (1) where a herd of cattle is free from tuberculosis and it is to be kept so, and (2) where one or more animals in the herd are infected and the purpose is to eradicate the disease and establish a sound herd.

PROCEDURE UNDER FIRST CONDITION.

The prevention of tubercular infection in cattle free from tuberculosis consists simply in keeping tuberculous cattle or other animals away from the sound ones—in keeping tuberculous animals out of pastures, sheds, or stables where the sound ones may be kept. Healthy cattle should not be exposed to possible infection at public sales or exhibitions. Raw milk or milk by-products from tuberculous cows should not be fed to calves, pigs, or other animals. Cars that have not been thoroughly disinfected should not be used for the transportation of sound cattle. Cattle that are purchased to go into sound herds should be bought from healthy or sound herds only.

PROCEDURE UNDER SECOND CONDITION.

The eradication of tuberculosis from infected herds requires for conservation of the herd different procedures according to the extent of the infection. For a guide to the control of the disease, tuberculous herds may be divided into three groups, namely:

I. Where 50 per cent or more of the animals are infected.

II. Where a small percentage (15 per cent or less) of the animals are affected.

III. Where a larger number (15 to 50 per cent) of the animals are diseased.

In eliminating tuberculosis from infected herds the following procedure is recommended:

Group I.

Herds where a tuberculin test shows 50 per cent or more of the animals to be infected should be treated as entirely tuberculous. The procedure here is as follows:

1. Eliminate by slaughter all animals giving evidence of the disease on physical examination.

2. Build up an entirely new herd from the offspring. The calves should be separated from their dams immediately after birth and raised on pasteurized milk or on that of healthy nurse cows. This new herd must be kept separate from any reacting animals.

3. The young animals should be tested with tuberculin at about 6 months old, and when reactors are found at the first or any subsequent test the others should be retested not more than six months later. When there are no more reactors at the six months' test annual tests should thereafter be made. All reacting animals should at once be separated from the new herd, and the stables which they have occupied thoroughly disinfected.

4. When the newly developed sound herd has become of sufficient size the tuberculous herd can be eliminated by slaughter, under inspection, for beef.

Group II.

1. The reacting animals should be separated from the nonreacting ones and kept constantly apart from them at pasture, in yard, and in stable.

- (a) *Pasture.*—The reactors should be kept in a separate pasture. This pasture should be some distance from the other, or so fenced that it will be impossible for the infected and noninfected animals to get their heads together.

- (b) *Water.*—When possible to provide otherwise, reacting cattle should not be watered at running streams which afterwards flow directly through fields occupied by sound cattle. The water from drinking troughs used by infected animals should not be allowed to flow into stables, fields, or yards occupied by sound animals.

- (c) *Stable.*—Reacting cattle should be kept in barns or stables entirely separate from the ones occupied by the sound animals.

2. Calves of the reacting cows should be removed from their dams immediately after birth. Milk fed these calves must be from healthy cows, otherwise it must be properly pasteurized. These calves should not come in contact in any way with the reacting animals.

3. The nonreacting animals should be tested with tuberculin in six months, and when reactors are found at the first six months, or any subsequent test, the others should be retested not more than six months later. When there are no more reactors at the six months' test, annual tests should thereafter be made. All reacting animals should at once be separated from the new herd and the stables which they have occupied thoroughly disinfected.

4. The milk of the reacting animals may be pasteurized and used.

5. Any reacting animals which develop clinical symptoms of tuberculosis should be promptly slaughtered.

6. An animal that has once reacted to tuberculin should under no circumstances be placed in the sound herd.

7. As soon as the sound herd has become well established infected animals should be slaughtered under proper inspection.

Group III.

Herds that come within this group should be dealt with either as in Group II, where the herd is separated, or as in Group I, where all of the animals are considered as suspicious, and an entirely new herd developed from the offspring.

GENERAL PRECAUTIONS.

In *all* cases animals that show clinical evidence of the disease should be promptly eliminated. They should be destroyed if the disease is evidently far advanced; if not, they may be slaughtered for food under proper inspection.

All milk from tuberculous cows that is used for food purposes should be thoroughly pasteurized. This means that it must be heated sufficiently to kill or to render harmless any tubercle bacilli that may be present in it. For this it is necessary to heat the milk for 20 minutes at 149° F., or for 5 minutes at 176° F. It is important that pails or other utensils used in carrying the unpasteurized milk should not be used, unless previously sterilized, for storing the milk after it is pasteurized.

When diseased animals are found, the stables from which they are taken should be thoroughly cleansed and disinfected. To accomplish this all litter should be removed; floors, walls, and ceilings carefully swept, and the floors, together with mangers and gutters, thoroughly scrubbed with soap and water. Thorough cleaning before the application of the disinfectant can not be too strongly emphasized. After cleansing, the disinfectant should be applied. A 5 per cent solution of carbolic acid, a 1 to 1,000 solution of corrosive sublimate, or a 4 per cent solution of sulphuric acid may be used. When the stable can be tightly closed, formaldehyde gas, properly used, is reliable and satisfactory.

If tuberculous cattle have been kept in a small yard, the litter should be removed, the surface plowed, and the fencing and other fixtures thoroughly cleansed and disinfected.



636.073
U58
B95C

GENERAL LIBRARY;
UNIV. OF MICH.
APR 24 1911

Issued March 23, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 176.

A. D. MELVIN, CHIEF OF BUREAU.

A SYSTEM OF POULTRY ACCOUNTING.

By ROB R. SLOCUM,

Animal Husbandman in Poultry Investigations, Animal Husbandry Division.

One of the greatest needs of most poultry keepers is a definite record of expenditures and receipts. In too few cases does the owner of a poultry flock actually know whether his fowls have been an expense to him or have paid a profit. This is perhaps truer in regard to poultry than with most other branches of animal industry, because of the facts that both expenditures and receipts are spread over the entire year and are individually small, that a large part of the product is used at home, and that the poultry keeping is incidental to the other farm work.

An effort is made to give in this circular, in the simplest form possible, a system of keeping an account of the poultry flock which will enable the owner to determine its status at the end of each year.

The different blanks or forms necessary are the following: Monthly sheet, yearly summary sheet, inventory sheet, balance sheet, and egg record. A sample sheet of each kind has been filled out for guidance in keeping such a record, except in the case of the egg record. These forms or blanks can be ruled off on ordinary loose sheets of paper or in a blank book. The latter plan will usually be found more desirable, as it prevents the different sheets from becoming scattered. When separate sheets are used they should be, for convenience, not less than 8 by 10 inches. When a blank book is used, one page can be used as the debit side of the sheet and the opposite page as the credit side, which will allow the use of a smaller book.

On the monthly sheet, one of which is used for each month in the year, all eggs and chickens used at home should be credited to the flock at regular market value. Eggs used for hatching at home should be both credited to and debited against the flock at the same price. This price should be their ordinary market value, unless the demand for eggs for hatching purposes is so great that all suitable eggs can be disposed of in this way; in that case the price should be

the regular rate obtained for hatching eggs. The labor of the owner can be estimated and charged against the flock each month if desired. The balance at the end of the year will then show the net profit of the flock. If only the extra labor which may be employed from time to time is charged, then the balance at the end of the year will represent the payment which the flock has made for the owner's labor. Under the column headed "Equipment" on the monthly sheet should be charged such purchases as incubators, brooders, etc. Lumber, roofing paper, glass, etc., should be charged under "Miscellaneous." Any day-old chicks sold would most properly be credited under "Breeding stock."

The yearly summary sheet consists, as its name indicates, merely of a summary of the monthly totals of expenditures and receipts for the year.

The inventory sheet should be used at the beginning of each year to take complete inventories of the equipment, stock, feed, etc. Each piece of equipment should be listed at its actual value at that time. In the case of buildings which are substantially constructed, 5 per cent deterioration should be sufficient to allow for the passage of a year's time. In case repairs have been made, the actual value of the building as repaired should be given and would probably overcome the deterioration and might even enhance the value over its value in the previous inventory. The deterioration on incubators, etc., with good care, should be about 10 per cent. The actual value of stock on hand should be given. The value may represent market value or its value as breeding stock. In the inventory, the feed on hand purchased or set aside for the poultry should be included. The time of taking the inventory, or the beginning of the year, need not be taken as January 1. Any other date may be chosen if deemed more suitable. Some poultry keepers prefer October 1 or November 1 as representing more truly the beginning of the poultry year.

The balance sheet will be understood by consulting the sample sheet given. This sheet shows the actual status of the flock for the year.

A simple egg record for the year is also given in blank. It will be found desirable to keep this record in connection with the account, as it will enable the poultry keeper to check up the number of eggs used at home, and thus be sure to credit the flock with them. Columns headed "Average number of hens" and "Average egg production" are also given and can be used if desired. By keeping these two columns one is enabled to check up the performance of the hens and determine whether they are giving a satisfactory egg yield.

The "average number of hens" can be easily determined if a record is made of the deaths each month. The exact average number would

be determined as follows: Suppose that in a thirty-day month there were 40 hens at the beginning of the month, that one died on the 8th and two on the 19th. For the first eight days there were 40 hens, for the next eleven days there were 39 hens, and for the last eleven days there were 37. Therefore the average number of hens equals

$$\frac{(8 \times 40) + (11 \times 39) + (11 \times 37)}{30} = 38.5.$$

An approximate average number of hens generally close enough for practical purposes can be obtained by taking the average between the number of hens at the beginning and the end of the month.

Having determined the "average number of hens," the "average egg production" is readily found by dividing the total number of eggs produced by the average number of hens.

Inventory January 1, 1910.

1 henhouse, 15 by 30 feet.....	\$100. 00
1 240-egg incubator.....	25. 00
2 indoor brooders.....	16. 00
2 colony houses, 8 by 8 feet each.....	40. 00
Miscellaneous—feed troughs, pails, pans, etc.....	10. 00
1 bushel wheat.....	1. 25
1 bushel corn.....	. 80
100 pounds beef scrap.....	3. 00
150 pounds bran.....	2. 25
50 barred Plymouth Rock hens.....	50. 00
50 barred Plymouth Rock pullets.....	75. 00
5 barred Plymouth Rock cock birds.....	10. 00
7 barred Plymouth Rock cockerels.....	14. 00
Total.....	\$347. 30

Inventory January 1, 1911.

1 henhouse, 15 by 30 feet; 5 per cent deterioration.....	\$95. 00
1 240-egg incubator; 10 per cent deterioration.....	22. 50
1 150-egg incubator, new.....	18. 00
2 indoor brooders; 10 per cent deterioration.....	14. 40
1 indoor brooder, new.....	8. 00
2 colony houses, 8 by 8 feet each, repaired; no deterioration.....	40. 00
Miscellaneous—feed troughs, pails, pans, etc.....	10. 00
2 bushels wheat.....	2. 40
1 bushel oats.....	. 60
100 pounds bran.....	1. 50
50 pounds beef scrap.....	1. 50
27 Barred Plymouth Rock hens.....	27. 00
95 Barred Plymouth Rock pullets.....	142. 50
2 Barred Plymouth Rock cock birds.....	4. 00
12 Barred Plymouth Rock cockerels.....	24. 00
Total.....	431. 40

[Cir. 176]

Monthly summary sheet.

Dr.

Cr.

Date.	Item.	Feed.	Equip- ment.	Labor.	Miscel- laneous.	Total.	Date.	Item.	Market eggs.	Hatch- ing eggs.	Market poul- try.	Breed- ing stock.	Total.
1910. Apr. 1	100 pounds beef scrap.....	\$3.00				\$3.00	1910. Apr. 4	10 dozen eggs, at 24 cents..	\$2.40				\$2.40
5	4 bushels shelled corn.....	3.00				3.00	10	1 pen breeding fowls.....				\$5.00	5.00
8	8 bushels oats.....	3.25				3.25	12	18 dozen eggs, at 24 cents..	4.32				4.32
8	Carpenter work on brooder.			\$2.00		2.00	13	1 hen (home use).....			\$0.55		.55
8	Lumber.....				\$4.00	4.00	14	3 market hens.....			1.80		1.80
10	Indoor brooder.....		\$8.00			8.00	15	8 dozen eggs (home use), at 24 cents.....					
10	6 gallons kerosene.....				.72	.72	17	15 dozen eggs, at 22 cents..	1.92				1.92
19	300 eggs for hatching.....				5.75	5.75	19	7 dozen eggs (home use), at 25 cents.....	3.45				3.45
20	100 pounds oyster shell.....	.80				.80	19	300 eggs, hatching (home use).....	1.61	\$5.75			5.75
25	3 bushels wheat.....	3.75				3.75	20	50 day-old chicks.....				3.00	3.00
							22	7 dozen eggs (home use), at 23 cents.....	1.61				1.61
							29	100 eggs hatching.....		3.00			3.00
							30	6 dozen eggs, at 22 cents..	1.32				1.32
	Total.....	13.80	8.00	2.00	10.47	34.27		Total.....	16.63	8.75	2.35	8.00	35.73

[Cir. 176]

Yearly summary sheet.

Dr.

Cr.

Date.	Feed.	Equip- ment.	Labor.	Miscel- lane- ous.	Total.	Market eggs.	Hatch- ing eggs.	Market poul- try.	Breed- ing stock.	Total.
1910.										
January....	\$11.25	\$18.00		\$2.45	\$31.70	\$21.65		\$2.35		\$24.00
February....	10.85		\$2.00	2.00	14.85	24.83		3.30		28.13
March.....	11.50	20.00		9.90	41.40	20.66	\$6.50	3.50	\$10.00	40.66
April.....	13.80	8.00	2.00	10.47	34.27	16.63	8.75	2.35	8.00	35.73
May.....	13.00			5.35	18.35	11.52	4.50	4.25	8.00	28.27
June.....	15.50		2.50	5.45	23.45	6.00	5.75	15.20	10.00	36.95
July.....	14.15			1.10	15.25	7.08	2.00	22.15	8.00	39.23
August....	13.80			4.95	18.75	5.37		13.90	4.00	23.27
September..	15.00		2.25	.45	17.70	9.10		10.80	3.00	22.90
October....	16.10			2.75	18.85	8.00		4.40	9.00	22.00
November..	4.80		1.00	1.43	17.23	8.17		7.85	15.00	31.02
December..	13.75			8.15	21.90	12.56		4.05	20.00	36.61
Total.....	163.50	46.00	9.75	54.45	273.70	152.17	27.50	94.10	95.00	368.77

Yearly egg record.

Day of month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.....												
2.....												
3.....												
4.....												
5.....												
6.....												
7.....												
8.....												
9.....												
10.....												
11.....												
12.....												
13.....												
14.....												
15.....												
16.....												
17.....												
18.....												
19.....												
20.....												
21.....												
22.....												
23.....												
24.....												
25.....												
26.....												
27.....												
28.....												
29.....												
30.....												
31.....												
Total....												
Average num- ber of hens...												
Average egg production ..												

[Cir. 176]

Balance sheet.

	DR.	CR.	BAL.
Value of inventory January 1, 1910.....	\$347. 30	.....	.....
Interest at 6 per cent on capital invested, as represented by value of inventory above.....	20. 84	.....	.....
Expenditures during 1910.....	273. 70	.....	.....
Value of inventory January 1, 1911.....		\$431. 40	.....
Receipts during 1910.....		368. 77	.....
Total	641. 84	800. 17	.....
Balance.....			\$158. 33

Approved:

JAMES WILSON,

*Secretary of Agriculture.*WASHINGTON, D. C., *January 26, 1911.*

[Cir. 176]



GENERAL LIBRARY,
UNIV. OF MICH.
MAY 17 1911

Issued April 22, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 177.

A. D. MELVIN, CHIEF OF BUREAU.

As numerous inquiries are being received regarding details of the procedure and requirements under the law and regulations providing for the importation of animals free of duty for breeding purposes, it has been thought well to issue the following information, prepared by Mr. G. Arthur Bell, senior animal husbandman in the Animal Husbandry Division of this bureau, who has immediate supervision of the bureau's work relating to this subject.

A. D. MELVIN,
Chief of Bureau.

INFORMATION FOR IMPORTERS OF ANIMALS FOR BREEDING PURPOSES.

Since January 1, 1911, in order to obtain the free entry of animals imported for breeding purposes under paragraph 492 of the tariff act of August 5, 1909, the customs officials of the Treasury Department have required evidence as follows:

The affidavit of the importer that he is a citizen of the United States and that the animals are imported specially for breeding purposes. This affidavit will be considered in connection with the circumstances of the importation, and any further evidence required which the collector may deem necessary to establish the allegations.

A certificate from the Department of Agriculture, stating that the animals are purebred, of a recognized breed, and duly registered in the foreign book of record established for that breed. With this certificate there must also be produced and submitted to the collector the certificate of record and pedigree on which the certificate of the Department of Agriculture is based, together with the affidavit of the owner, agent, or importer that such animals are identical with those described in the said certificates.

In case any of the foregoing evidence can not be furnished at the time of the arrival of the animals a voluntary bond may be given by the importer in double the amount of the estimated duties, conditioned for the production of the required evidence within six months, which bond may be extended in exceptional cases for a like period on application to the Secretary of the Treasury, and shall be canceled only upon the production of the evidence for which it is given or upon payment of full liquidated duties. Should the importer so elect, estimated duties may be paid and a written stipulation filed with the collector within 10 days thereafter to produce the evidence within six months from the date of entry, whereupon the final liquidation will be suspended until the production of the evidence or the expiration of the six months. (T. D. 31147.)

In order to obtain the certificates of the Department of Agriculture, the importer should submit to the Chief of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., the certificates of registration and pedigree (in the case of dogs registered in the English Kennel Club Studbook the pedigree certificates should be submitted) issued by one of the pedigree record societies listed in B. A. I. Order 175, "Regulations governing the certification of recognized breeds and purebred animals." (See amendment 1 to this order, regarding animals registered in the Canadian National Records.) These certificates should be accompanied by an application for the certificates of the bureau and by vendor's certificates rendered on forms furnished or approved by the department. In case the vendor's certificate forms part of the certificate of registration, no other vendor's certificate is necessary, provided it contains the information required by this department.

The application for certificates should show the number, breed, and sex of the animals imported, the name and address of the importer, the port of entry, the name of vessel, and the date of arrival. But one application for certificates is necessary for each breed in a single importation. For convenience in filing, the department has a separate form for each class of animals, as follows: Form A. H. 105 for horses, Form A. H. 105a for cattle, Form A. H. 105b for sheep, Form A. H. 105c for hogs, Form A. H. 105d for dogs, and Form A. H. 105e for cats.

The vendor's certificate should give the address of the vendor, the date the animal is sold, the name and address (in the United States) of the purchaser, the name and registry number of the animal, and must be signed by the person selling the animal to the importer, or by the seller's agent; and if signed by the agent of the seller, the name of the seller for whom the agent is acting should also be given. The blank vendor's certificates furnished by the department are issued in two sizes. Form A. H. 106 contains space for 4 animals and should be used when not more than 4 animals are purchased from the same person; Form A. H. 106a has space for 16 animals.

The blank forms for application for certificates, vendor's certificates, and copies of B. A. I. Order 175 and amendments thereto may be obtained free on application to the Bureau of Animal Industry. When applying for these the importer should state about the number of forms which will be required for his importation.

It is desirable to have the application for certificates, the vendor's certificates, and the foreign certificates of registration reach the bureau a day or two in advance of the arrival of the animals at the port of entry, in order that there may be as little delay as possible in issuing the certificates of this bureau. In no case, however, are these certificates issued until the descriptions taken by one of the

bureau's inspectors at the port of entry are received at the office in Washington. The importer or his agent should be prepared to furnish the bureau's inspector at the port of entry with the names and registry numbers.

On the arrival at the port of entry of animals which are not subject to quarantine, the importer will be required to give the bond heretofore mentioned, or to deposit the estimated duties with the collector with a stipulation to produce the certificates of this department within a period of six months. In the case of animals subject to quarantine the bond or stipulation will not be required, as it will be possible to have the certificates of this department reach the collector before the expiration of the quarantine period. In the case of animals subject to quarantine the importer may, if he desires, leave the foreign certificates with the superintendent of the quarantine station. The animals will then be checked with the data regarding sex, color, etc., contained in the foreign certificates. When this has been done the superintendent of the quarantine station will forward the foreign certificates to Washington with his report. Such animals will not, however, be released from quarantine except upon notice from the collector of customs that all requirements of the customs regulations relative to their entry have been complied with by the importer.

If the application and accompanying papers are satisfactory, certificates of this bureau will be issued and sent with the foreign certificates direct to the collector of customs at the port of entry. After having served the purpose of the collector, the foreign certificates are returned to the importer, and the certificates of this department are retained for the files of the Treasury Department.

Each foreign certificate in connection with which a certificate of pure breeding of this bureau has been issued bears a stamp to that effect.

All inquiries regarding the duties on animals, the liquidation of entries, the return of animals which have been sent out of the United States to be bred, or the free entry of animals for temporary exhibition purposes should be addressed to the Treasury Department, and not to the Department of Agriculture, except those relating to inspection and quarantine regulations.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., March 4, 1911.

[Clr. 177]



36.073

158

395C

GENERAL LIBRARY;
UNIV. OF MICH.
MAY 17 1911

Issued April 19, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 178.

A. D. MELVIN, CHIEF OF BUREAU.

BREEDING HORSES FOR THE UNITED STATES ARMY.¹

Although horses are now commanding higher prices than have been known for many years, there is evidently a great shortage in their production. The United States Army has for some years found it difficult to maintain an adequate supply of suitable horses, and it seems that if the efficiency of the cavalry is to be maintained it will be necessary for the Government to take up some systematic plan to encourage the breeding of horses of a type suitable for Army use.

During the past year the Secretary of War requested the cooperation of the Secretary of Agriculture in evolving some plan for enabling the Army to obtain suitable horses. The Secretary of War pointed out that the supply of horses fit for remounts is becoming more and more limited, and that the present indications are that the country would find it impossible to mount its Army from its own resources in time of war and is rapidly reaching a point where the needed supply of suitable remounts for the present strength of the Army would be extremely difficult to obtain, if obtainable at all. As a result this department designated a representative to join with a representative of the War Department in considering the subject and formulating a plan. The Department of Agriculture was represented by Mr. George M. Rommel, Chief of the Animal Husbandry Division of the Bureau of Animal Industry, and the War Department by Capt. Casper H. Conrad, jr., Third Cavalry, United States Army, detailed for duty in the Quartermaster General's Department in connection with the purchase of remounts. These gentlemen have outlined a plan for breeding horses for Army use, which is presented in the following pages. The statement setting forth the reasons why the War Department regards it as imperative for the Government to undertake the work of encouraging the breeding of horses for the Army was prepared by Capt. Conrad and is inserted

¹ From the Report of the Chief of the Bureau of Animal Industry for 1910.
86064*—Cir. 178—11

here with the consent and approval of the Quartermaster General. The plan for breeding the horses was prepared by Mr. Rommel with the assistance of Capt. Conrad and other officers of the Army stationed in Washington, and has been formally approved by the War Department. To carry out this plan would require appropriations for the use of the Department of Agriculture estimated at \$250,000 for the first year and \$100,000 a year thereafter.

THE NECESSITY FOR GOVERNMENT ENCOURAGEMENT OF BREEDING ARMY HORSES.

The difficulty experienced by the Quartermaster's Department in procuring remounts seems perfectly natural. The early settlement of the United States, particularly the eastern part, went on some time before the advent of steam and electric transportation, and the settlement of the western part even now in the most remote points takes place without the assistance of modern transportation. In all new countries the horse has played an important part in the advancement of civilization and the general scheme of settlement. Even in the first part of the nineteenth century the horse was a very much more important animal in Europe and the British Isles than at present.

During the opening of a country the settler must, owing to the absence of roads and other forms of transportation, put his principal reliance upon the horse; he is forced to travel trails and long distances, and for this purpose finds that he needs a horse suitable to carry him quickly and comfortably to his destination. To accompany him and carry the articles necessary for his daily life, he needs a pack animal. So long as conditions remain unchanged, a desirable type of saddle and pack animal will exist in good numbers; but so soon as the country becomes more settled and habitations more permanent, the mountain trail gives place to the road, and later the country road to the worked and metaled highway, and the type of horse rapidly changes. The necessity for the saddle animal lessens; the light-draft animal becomes more important; the people ride less and discard the expensive pack transportation; the horse is attached to a light vehicle with which he is able to transport more than one person or a heavier load. As the roads become better and the country more extensively cultivated, the lighter horse is used more for pleasure or solely as a means of drawing the carriage; another type of horse becomes more useful and economical, and the light-draft type appears to be succeeded by the heavy draft. Next come the railroad, the trolley line, and the automobile. The people ride and drive less, and fewer horses of the riding types are bred. Riding is indulged in almost solely for pleasure. A new country is a country on horseback; an up-to-date one, a country in an easy chair.

In the United States the type of horse suitable for Army purposes is now proportionately less numerous because it is not found necessary to the civilians of the country, and the Quartermaster's Department is finding it each year more difficult to supply the yearly demands of the mounted branch of a small Army.

The horses of our mounted branches are severely criticized by representatives of foreign armies, while from our own officers come reports of poor animals, poor performance, many quickly developed unsoundnesses, and short life.

As an illustration—in the West it is found that a marked change has taken place in recent years in the so-called "cow pony." Twenty years ago cattle ranches of the West were practically without fences and unlimited, and the cow man found it necessary to breed and use a type of quick, active pony. As the West became settled and as agriculture was taken up the large free ranges changed to the large fenced pastures of a few years ago. These large pastures are now being broken up into even smaller ones. The yearly round-up requiring riding over immense distances and active work has about disappeared. To-day cattle are not chased and roped, but are driven into the small pastures and pens and quietly handled. The quick cow pony of the past has given place to a larger animal, frequently having a cross of draft blood. It may be said that the cow pony of the West has practically disappeared.

Virginia has long been famous for the horse known as the Virginia hunter. Even the breeding of this type of horse has been sadly affected by the high price of heavy draft horses, and further influenced by the fact that only those hunter-bred horses that attained full size brought high prices. Under the haphazard methods of breeding in vogue in these sections not more than 1 in 6 colts could be depended upon to attain the size necessary to bring a high price, and the farmer found himself the possessor of 4 or 5 small horses for which there was no steady market. When he found that all draft colts, in spite of minor blemishes, brought good prices as 3-year-olds, he at once ceased to breed the hunter type, with its many misfits, and commenced on heavy draft horses. The disappointment in the hunter-bred horse would not have been so great had the breeding of this type been done scientifically and rationally. The hunter-bred horse as now raised in Virginia is sired almost entirely by stallions either sent to the country gratis or sold at small prices to individuals by wealthy people in the North who desire hunters and are looking to the future supply. A farmer living in the neighborhood of a Thoroughbred stallion, and feeling that he would like to breed a hunter, will take advantage of the nearest and cheapest stallion in his neighborhood,

regardless of what the result may be. All that he considers necessary is that the horse should be, first, a Thoroughbred; and, second, that he should be a pleasing individual; never taking into consideration the fact that the mare might not be suited to the horse nor the horse to the mare. Hence the misfits, the discouragement, and the decrease in number of the hunter type. It is said that not one-tenth as many hunters are bred in Virginia to-day as formerly.

Even more appalling than the present scarcity of horses suitable for military purposes in this country is the large number of unsound horses that are constantly being examined by purchasing officers. Horses of this class can be the result of but one thing, and that is an absolutely irrational system of breeding, or the lack of any system whatsoever. When it is remembered that a sound and serviceable horse of a particular type costs no more to raise than an unsound horse, the immense waste caused by our present lack of system is only made more apparent.

The enactment in a number of States of laws whose effect is to prohibit the standing of unsound stallions for public service will no doubt, in time, tend to correct this evil; but not until the horse-raising States generally prohibit absolutely the public stud service of unsound stallions will unsound horses be less common on the market. Such legislation in one State is an excellent thing for that particular State, but it is very likely to drive all the unsound stallions across the borders into adjoining States where laws against the unsound stallion do not exist.

The next census will probably show that there are in the neighborhood of 23,000,000 horses in the United States. It would seem that in this immense number there must be many thousands of horses suitable as remounts for the Army, and there probably are; but the fact that the type desired is comparatively scarce, and that the horses that would do are scattered over an immense area and are in demand for other purposes than the military, makes it not only expensive and impracticable to obtain them, but next to impossible to do so.

The purchase of young horses for the Army during the last fiscal year has been more or less successful, but all officers connected with the Quartermaster's Department have reported that while they were obtaining a fair number of horses, they could see no prospect of obtaining them in any number in future years, and all report the apparent necessity for the Government's assistance in the rational breeding of Army horses in the country.

As no system of supply, so far as the Army is concerned, which deals with peace conditions alone, is complete, the War Department must constantly keep in mind the possibilities of war, and it is not surprising that, finding difficulty in purchasing a supply of remounts

for the peace Army, there should be more or less uneasiness when war requirements are considered.

The waste of horseflesh in war times is enormous, and in a war of any magnitude in which this country might be engaged the number of horses required will not be confined to the thousands per year, but will extend into the hundreds of thousands.

In this connection attention is invited to a few of the records on this subject:

There were purchased for the armies of the Federal Government in the fiscal year ending June 30, 1864, 188,718 horses. There were captured from the enemy and reported 20,388. Leaving out of consideration those captured and not reported, it should be observed that the Army required 500 horses each day for remounts. This, therefore, is the measure of destruction of horses during the same period.

During the eight months of the year 1864 the cavalry of the Army of the Potomac was supplied with two remounts, nearly 40,000 horses. The supply of fresh horses to the army of Gen. Sheridan during his campaign in the Valley of the Shenandoah has been at the rate of 150 per day.

During the Russian campaign the French crossed the Nieman in June, 1812, with cavalry, artillery, and train horses to the extent of 127,121. About 60,000 of these pertained to the cavalry. On December 13 the remnant of the invading army recrossed the Nieman with 1,600 cavalry horses. In six months the horses had all disappeared.

Examples of the terrible waste of horseflesh during war might be multiplied ad libitum.

The question of remounts for the Army became so serious during the Civil War that in 1863 the Cavalry Bureau was established. One of the principal duties of this bureau was the purchase and inspection of horses for the Army. Six remount depots were established. The most important of these was Giesboro Manor, situated on the north bank of the Potomac, nearly equal distance between Washington and Alexandria. To show the magnitude of operations of the Cavalry Bureau, the following report of the Giesboro depot is given:

On hand Oct. 1, 1863, cavalry horses.....	4, 281
Received to Dec. 31, 1863.....	36, 932
Total.....	41, 213
Issued.....	22, 204
Sold.....	1, 651
Died.....	1, 637
Total.....	25, 492
On hand Jan. 1, 1864.....	15, 721
Received by purchase, Jan. 1, 1864, to June 30, 1863.....	5, 326
Received from other depots for issue.....	59, 507
Received for recuperation.....	85, 980
Received by transfer from Artillery.....	4, 120
Total.....	170, 654

Issued to armies in the field.....	96, 006
Issued to officers after June 30, 1865.....	1, 574
Issued for sale or sold at depot.....	48, 721
Died.....	24, 321
Total.....	170, 622
On hand June 30, 1866.....	32

This does not take into consideration the twelve or thirteen thousand artillery horses handled at this depot.

This report closes with the abandonment of the depot, but it is to be remembered that nearly all the volunteer cavalry was mustered out immediately after the surrender of Gen. Lee's army the preceding year, so that nearly all the horses were handled during a period of 18 months.

Until recently acts of Congress appropriating money for the purchase of horses for the Army required that they should be purchased by contract from the lowest responsible bidder after advertisement. The specifications of the horse to be delivered under contract are those of a perfect animal, which, of course, is seldom seen. The inspectors and purchasing officers are required to reconcile these specifications with existing conditions, keeping in mind fairness both to the contractor and to the Government. This system led to the building up of the class of middlemen who purchased animals from the breeders, presented them for the action of the Government inspectors, and sold them at the contract price. Until recently this price ranged from \$100 to \$150. Considering the large expense to which the contractor would be put, it could not be expected that all of the Government's money would be invested in horseflesh. The result was, considering the profit by the contractor, his expenses, etc., that the price paid by the Government secured for the cavalry a horse worth from \$70 to \$100. Nothing is known of the breeding of these animals further than that they were "probably of such and such breeding." Often the question of breeding was not raised, the principal requisite being that they should give promise of performing the duties expected of them.

The contract system has tended to discourage the horse breeder of the country, as the money paid him by the contractor, after much haggling, was often very little more than the cost of raising the horse. There has been no incentive for breeders, even in the best naturally endowed sections, to breed the type of horse that the Army needs.

Again, in recent years the demands for heavy draft animals for farming purposes, the high prices that these animals are bringing, the fact that they cost no more to raise, and bring even a higher price although blemished, has had a further bad effect upon the breeding of the desired saddle type. Even before the present high prices of all

horses and the higher price of the draft horse existed, the breeding of the type considered best for Army purposes received another severe setback by the adoption of electric and cable street railways and the extension of the trolleys. While not generally appreciated, the best "railroaders," as the horses used for street cars were called in the market, were the very kind that made the best cavalry mount. This horse was desirable for street-car purposes because of his endurance and his willingness to work.

The contract system received its first serious setback, from the contractor's standpoint, when the Army, due to the clamor for better mounts, insisted upon a closer compliance with the contract specifications and rejected more of the horses presented by the contractor. The sudden rise in the price of horses further embarrassed the contractor, and the added difficulty of obtaining horses to present for inspection caused many of the contractors to fail in their deliveries, made others reluctant to bid, later led to the impossibility of obtaining horses under this system in certain sections, and finally led to authority being given by Congress for open-market purchases. This method, while apparently a little more expensive to the Government, had the advantage of eliminating the middleman, giving the breeder all the money which the Government was willing to pay for horses, and giving the Government value received in horseflesh.

The establishment in 1908 of the remount depots has further improved the type of horse for the Army, as the system of purchasing young horses 3 and 4 years old, often unbroken, has enabled the Government to get the best type of horse before he has cost the breeder much money and when he could be sold for a reasonable amount. These horses, sent to the depots for maturing and handling, and finally issued to troops as 4½ and 5 year olds, while costing the Government more per head than the horses 5 and 6 years old formerly purchased and issued directly to troops, are very much better horses from the beginning, are properly developed at a critical period in their existence, rationally handled, and, when issued to troops, have been received with enthusiasm as a great improvement over the matured horses formerly issued under the old system. Even considering the high market value of horses at present, it is believed that, under the remount system, horses can be issued to troops at not to exceed a total average cost of \$225. The latest contract price of Cavalry horses is \$183.75; for Artillery horses, \$213.75. Many of the late contract horses are young and require some handling at depots before suitable for service; others are mature.

Horses purchased as mature under the old system have had a useful life in the Army of 6.4 years on an average. The better grade of horses, such as are now being purchased, rationally developed and handled, should and will have a useful average life of 10 years. It is

easy to see that the better horse issued from the depot at a cost of \$225 that lasts 10 years is cheaper than the horse costing from \$183 to \$213 lasting only 6.4 years. In addition the Army will have had a better horse throughout the entire period of usefulness. The horses being issued from the depot could undoubtedly be sold at time of issue at a handsome profit. Many individuals would bring fancy prices. It is needless to say that if it were possible to purchase them in issue form, it would be necessary to pay much more than they have cost under the depot system.

European countries long ago found it not only advisable but necessary to supervise the breeding of horses in order to supply the demands of their armies, and every European country of importance, with the exception of England, has for years been encouraging the breeding of the proper type of army remount. England, one of the most important horse countries of the world, has for many reasons only recently been forced to this step. It is interesting to note that practically the same conditions confront England that confront this country at the present time, and that almost identical steps are contemplated in the two Anglo-Saxon countries to accomplish the same result—suitable army horses in sufficient number.

A PLAN FOR BREEDING HORSES FOR THE UNITED STATES ARMY.

NUMBER OF STALLIONS REQUIRED.

From the best information available it would appear that a comprehensive plan to breed the horses needed for the mounted service of the Army on the present peace footing should provide for not less than 2,000 horses a year and need not exceed an estimated allowance for over 2,500 a year.

To determine the number of stallions needed for this work, allowances must be made for failure of stallions to get in foal all mares served, for ordinary losses of foals, and for failure of foals bred to prove suitable for remounts.

A good sound stallion will get about 75 per cent of his mares in foal. Of the resulting foals, an average of at least 10 per cent will die from various causes before they are old enough to be purchased as remounts. In the proposed Army horse-breeding work probably about 50 per cent of the remainder would be suitable for remounts.

Based on an estimate of 100 stallions, the following results could be expected for varying numbers of mares served by each stallion:

Number of mares covered by each stallion.	Estimated number of suitable remounts by 100 stallions.
40	1,350
50	1,668
60	2,025
70	2,363

An estimate of 100 stallions would therefore appear to be conservative. It is doubtful if stallions average more than 70 mares a season, as a rule. In some localities it would probably be possible to stand stallions for a short fall breeding season in addition to the usual spring season, in which case a larger number of mares could be covered. In others only a spring season would be feasible, and a smaller number of suitable mares might be offered.

DISTRIBUTION OF STALLIONS.

The country should be divided into four or more breeding districts, as follows, and stallions assigned as indicated:

New England district (vicinity of Maine and New Hampshire).....	10 Morgans.
Central district (Virginia, West Virginia, Kentucky, and Tennessee, with perhaps certain sections of Indiana and Ohio)	30 Thoroughbreds.
	10 Standardbreds.
	10 Saddlers.
Southwestern district (vicinity of Missouri or Texas, with perhaps certain sections of Iowa)	5 Thoroughbreds.
	5 Saddlers.
	5 Standardbreds.
Northwestern district (Montana, Washington, Oregon, and perhaps California)	15 Thoroughbreds.
	10 Standardbreds.
Total	100

It might be well to subdivide one or more of these districts. The above arrangement is worked out to establish such districts so that they will be in reasonable proximity to Government stations where the stallions may be kept between breeding seasons.

NUMBER OF REMOUNTS AVAILABLE ANNUALLY.

Based on the foregoing estimates, the number of remounts available yearly from these sections would be as follows, with stallions covering the maximum of 70 mares, and taking 24 as a convenient unit for the number of suitable remounts got by each stallion annually:

New England district.....	240 Half-Morgans.
	720 Halfbreds.
Central district	240 Half-Standardbreds.
	240 Saddlers.
	120 Halfbreds.
Southwestern district	120 Saddlers.
	120 Half-Standardbreds.
Northwestern district	360 Halfbreds.
	240 Half-Standardbreds.
Total	2,400

A considerable number of the horses sired by the Morgan and Standardbred stallions would be suitable for cavalry remounts, but a much larger number would be preferable for the field artillery. The number of estimated remounts by Morgans and Standardbreds is 840. In selecting stallions of these breeds due consideration should be given the necessity for artillery remounts.

SELECTION OF BREEDING DISTRICTS.

Those localities should be selected for breeding districts where conditions are especially suited to horse raising, where the type of mares is most likely to approach the type of horses desired for the Army, where a light type of horse will always in the long run be the most profitable to the farmer and draft horses least likely to gain a firm foothold, and where mares are sufficiently numerous to give the stallions maximum service. A careful survey of the horse-raising districts of the country will be necessary before this question is settled, and the returns of the Thirteenth Census can probably be used. The Bureau of Statistics of the Department of Agriculture states that it is impossible to use its returns for this purpose. Perhaps, however, that bureau could assist in making the survey.

The Government reservations where stallions would be kept between the breeding seasons would be the points around which the work would center. In some cases it might be possible to stand some stallions on the central station itself. Stallions should be distributed in lots of five around the central stations, and such further distribution could be made as necessity required. At the close of the season they would be returned to the central station and kept there until the next season or sent to another locality.

THE EXPERIMENTAL FEATURE.

The plan has experimental possibilities of the highest order, which should be utilized. The leading features are the test of the value of different breeds to produce remounts and the value of different soils and climates for the purpose, which could soon be determined by the Army by keeping records of performance. Certain troops, squadrons, and batteries, and entire regiments, could be supplied with remounts bred in a certain way in certain localities, and the possibilities of the plan from an experimental standpoint would thus become very great. By the time a second large appropriation to purchase stallions would, if ever, be necessary, the Government would be in possession of facts which would enable it to show definitely whether the plan had been successful, and whether any crosses or localities should be eliminated from further consideration. It might be well, also, to consider the feasibility of arranging with the breeders to reserve a small number of high-class fillies each year for breeding purposes; otherwise mare owners would be compelled to replace their mares by purchase, which would bring the problem little nearer solution at the end of 20 or 50 years than it was at the beginning. That it is possible in time to fix the type desired for remounts is by no means questionable, and this may indeed be very desirable.

TERMS OF SERVICE.

No mare should be bred to a Government stallion until she has been approved by the proper officer as of the type suitable to produce remounts. The common unsoundnesses, the tendency to which may be transmitted from one generation to another, should naturally disqualify a mare, but even more important would be the necessity to refuse a mare on account of manifest faults of conformation, action, or quality.

The terms of service should be free, the owner of the mare entering into a contract to give the War Department an option on the resulting foal during the year it is 3 years old (estimating a horse to be 1 year old on the 1st of January after it is foaled) at a price to be fixed before the mare is bred. A provision should be included in the contract that the mare must remain in the owner's possession until the foal is weaned, and that, in case the foal is sold before the War Department has exercised its option, a service fee shall be exacted from the breeder of the foal. Provision should be made, however, to cover such emergencies as the death of the breeder, etc.

The price contracted to be paid for remounts should be fixed annually for each State by a board of arbitration before the breeding season opens, subject to the approval of the Secretary of War. For example, in January or February, 1912, this board would meet in each State mentioned above and agree upon the price to be paid for remounts bred in that State to be purchased in 1916; in 1913 prices to be paid in 1917 would be fixed, and so on. The arbitration board should be composed of an officer of the Army, an officer of the Department of Agriculture, and a citizen residing in the State, preferably a competent horseman. In purchasing remounts, no discrimination should be made against mares; colts should have been castrated at the breeder's expense, preferably between 1 and 2 years of age.

ORGANIZATION.

The breeding work would be administered by the Bureau of Animal Industry of the Department of Agriculture through the Chief of the Animal Husbandry Division. This division would direct the work under the supervision of the chief of the bureau, and keep the breeding records and the reports on the development of the foals. Not later than January 1 of each year it should furnish a report for transmission to the War Department on the actual number of 3-year-olds in each breeding district available for purchase during the year and the probable number of these that will make satisfactory remounts. A competent animal husbandman should be employed, with headquarters at Washington, as a traveling inspector of breeding sta-

tions, to keep the department in close touch with the work in addition to receiving regular reports from the breeding districts.

The men in charge of the breeding districts should be obtained from the field force of the Bureau of Animal Industry. These men should be good veterinarians, with a thorough knowledge of horse husbandry. Their field experience would make them invaluable for this work, and the loss to the field service of the bureau would be more than compensated by the fact that they could handle the work better than any men who might be obtained from the outside. If the Government undertakes this project it must do so under the most favorable auspices, and no risk of failure should be run. As success would largely depend on the ability of the men in charge in the field, the best men available should be obtained. The expert assistants to men in charge of breeding districts should be animal husbandry graduates of agricultural colleges, and not veterinarians. This would balance the service in a very effective way.

The duties of these men would be to direct the work at the breeding stations in their districts, to attend to the keeping of the records, to advise mare owners on the care of horses, and, if possible, to travel through their districts before the breeding season opens and approve mares, directing how they should be bred, if necessary. Until the work is on a thorough, well-organized basis, the approval of mares should be done by the men in charge of districts or their expert assistants.

The men in charge of stallions as stud grooms should be employees of the Department of Agriculture, for whose appointment experience in the handling of horses should be the first consideration. Preference should be given men who had been honorably discharged from the mounted service of the Army and who presented certificates from officers in whose commands they had served showing their proficiency in horsemanship.

It is hardly necessary to point out the desirability of having the breeding service so organized that it will be carried on from year to year by the same or about the same corps of employees, in order that it may have a definite, stable, and continuous policy.

THE PURCHASE OF STALLIONS.

Stallions should be purchased by a board of three, composed of an officer of the Army, an officer of the Department of Agriculture, and a practical horseman. whose knowledge of breeds, pedigree, and markets and whose integrity can be relied upon.

In selecting the stallions, suitability for the purpose and freedom from unsoundness likely to appear in progeny should, of course, be first considered, and the stallions should be old enough to have shown

their worth as sires of the class of horses desired. In buying Standardbreds, Saddlebreds, and Morgans any tendency to pace, rack, mix gaits, paddle in front, sprawl behind should disqualify, and only those stallions should be selected which come from families which show none of these tendencies to a marked degree. The presence of such faults in their get would, of course, disqualify them.

EXPENSE.

It is believed that this plan could be put into full operation at a cost not to exceed \$250,000 for the first year. This will allow for the purchase of first-class stallions with proved stud records and will provide for the employment of first-class men to carry on the work. The expense in subsequent years, on the same basis of 100 stallions, would require appropriations estimated at \$100,000 annually, which would allow for the replacing of stallions as necessity required.

On the basis of 40 mares per stallion the system would cost about \$40 per colt produced. If the maximum of 70 mares were covered by each stallion, the cost per colt produced would be about \$20. Considering the fact that the normal stud fee in the country is from \$10 to \$25, with a probable average of \$15, it will be seen that under this system the expense would be somewhat greater than by using privately owned stallions, but it is believed that the advantages of breeding and the results in foals would more than compensate for the increase. While the increased cost would not necessarily be made up to the Central Government, the increase in State and local taxes on more valuable foals would more than counterbalance the loss under this system. As a matter of fact the resultant cost of such a careful system of breeding can not be computed in dollars and cents, particularly as the effect of systematic effort in the breeding of Army remounts should have such a favorable influence on all breeding in this country as to be of inestimable benefit to the horse industry and far outweigh any expense that might be debited against this system.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *March 10, 1911.*



6.013
158

Issued May 1, 1911.

U. S. DEPARTMENT OF AGRICULTURE, GENERAL LIBRARY,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 179. UNIV. OF MICH.

JUN 18 1911

A. D. MELVIN, CHIEF OF BUREAU.

COW-TESTING ASSOCIATIONS.

BY

HELMER RABILD,

*In Charge of Dairy Farming Investigations, Dairy Division,
Bureau of Animal Industry.*



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; R. A. RAMSAY, MORRIS WOODEN, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

DAIRY DIVISION.

B. H. RAWL, *Chief.*

HELMER RABILD, *in charge of Dairy Farming Investigations.*

S. C. THOMPSON, *in charge of Dairy Manufacturing Investigations.*

L. A. ROGERS, *in charge of Research Laboratories.*

GEORGE M. WHITAKER, *in charge of Market Milk Investigations.*

ROBERT MCADAM, *in charge of Renovated Butter Inspection.*

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., March 14, 1911.

SIR: I have the honor to transmit herewith a paper on "Cow-Testing Associations," by Mr. Helmer Rabild, in charge of dairy farming investigations in the Dairy Division of this bureau.

The low average production of the dairy cows of the United States is a condition that does more than any other one thing to prevent development and to render dairying unprofitable. The cow-testing associations afford a plan for testing the cows and keeping a systematic record of every cow in a herd, so that the unprofitable ones may be identified and eliminated, and also provide other cooperative advantages. These associations originated in Europe, where they worked so well that the plan was introduced with some modifications in the United States. This department has assisted State officials and institutions in promoting and directing the work, and the results have been very successful in many ways.

Mr. Rabild's paper gives the history of the movement, describes the plan of operation, and shows the advantages of these associations. This paper forms a part of the Twenty-sixth Annual Report of this bureau, but in order that it may be given a wider circulation I respectfully recommend that it be published also as a circular of this bureau.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Cow-testing associations in Europe	5
Origin	5
Growth of the movement	6
Purpose and plan of the associations	7
Improvement as shown by records	8
The cow testers	9
General results in Europe	10
Associations in the United States	10
Opportunity and need	10
The practical difficulty	11
The elements of economy	12
The first American association	13
Methods of operation	13
A Michigan association's record for the first four years	15
Method of organizing	16
The testing outfit	17
Qualifications of the tester	18
Accuracy of results obtained by various testing methods	18
Meetings	19
Growth in the United States	20
Results	20
Relation of the United States Department of Agriculture to the work	22

COW-TESTING ASSOCIATIONS.

COW-TESTING ASSOCIATIONS IN EUROPE.

ORIGIN.

The cow-testing movement in connection with dairying originated in Denmark and was a direct result of necessity. That little country during the latter part of the nineteenth century passed through a financial crisis, the result of which was a reorganization of agricultural activity. Destructive and expensive wars had drained the resources of the country and increased the national debt, and the farmer, upon whom fell the burden of taxation, was forced to follow that system of agriculture which promised the highest possible returns. Beef production had become unprofitable by reason of increased land values and discrimination in foreign markets. The good standing of Danish butter and the prices paid for it on the English market gave promise that dairying, if properly developed, might furnish a good source of revenue, and this industry, which previously had been carried on in an indifferent way, began to assume greater importance. It received a great stimulus by the organization of a few cooperative creameries, the first of which was organized in the year 1882. The cows on the farms had not been selected for dairy purposes, the average production of butter per cow in 1884 being only 112 pounds a year, and the farmer soon learned that more productive cows were an absolute necessity if he would derive any profit from the business. Some importations of dairy cattle of foreign breeds were made. These importations, however, brought in many cases disappointment and loss and were soon discontinued, and the farmers began, by studying the individuality of their native cows, to breed a strain of cattle which were especially suited for dairy purposes.

The cow-testing movement began in 1892, when State Counselor B. Bøggild, at a meeting of the Kildebrønd Creamery patrons in July of that year, explained how records of the individual performances of the cows could be obtained, and the result was that 14 farmers agreed to weigh the milk from each cow and send samples of it to the creamery. The creamery manager, Mr. Hansen, determined its richness by the Fjord centrifugal cream tester and published the record of the milk and butter yield from each cow, as well as the feed consumed. Shortly thereafter, and as a result of this, those men who had kept records formed the Kildebrønd Bull Association, with the object of improving their herds.

State Counselor Frederik Hansen, a dairy expert employed by the Government and the owner of a dairy farm, had for several years studied the richness of the milk of individual cows by occasionally taking samples to the creamery for testing, and he had begun weeding out the animals in his herd which gave poor milk, thereby increasing the richness of the herd's milk. His neighbors who sent milk to the same creamery, noticing the increase in richness of the milk from his herd, began to inquire into the cause of it, and when sufficient interest had developed Mrs. Hansen, his wife, suggested that an association be formed in the neighborhood for the purpose of investigating the richness of the milk of individual cows and the economy of their production, so that each member of this association might obtain the same benefit that Mr. Hansen had derived from such investigations.

A meeting was called for this purpose January 23, 1895, on the farm of Søren Peter Knudsen, at Lille Skovgaard, Vejen, and the first cooperative cow-testing association was organized. A dairy expert was employed to make examination of the richness of the milk with the Gerber butyrometer and keep the milk and feed records. Active operations began May 1, 1895, with 13 members, and so satisfactory have been the results that the association now numbers 24 members, with 522 cows, and employs 2 men as cow testers.

GROWTH OF THE MOVEMENT.

Another association was organized later during the same year, and since then the movement has grown wonderfully. From Denmark it has spread to other European countries.

The following table shows the growth of the cow-testing movement in Europe. The figures given show the number of associations in the various countries, by years:

Number of cow-testing associations annually in operation in European countries, 1895 to 1909.

Year.	Denmark.	Germany.	Sweden.	Norway.	Finland.	Holland.	Russia.	Scotland.
1895	2							
1896	15							
1897	30	1						
1898	88	2	1	2				
1899	170	8	8	6	1			
1900	219	4	28	19	2			
1901	260	9	71	60	3			
1902	307	18	136	108	4			
1903	362	29	188	137	7		a 1	4
1904	415	63	270	145	11	b 36	(a)	1
1905	448	63	333	139	17		(a)	2
1906	479	63	413	142	38		(a)	5
1907	479	63	486	145	64	86	(a)	7
1908	508	207	593	146	83	(c)	(a)	13
1909	530	207	662	146	99	(c)	d 52	13

* Organization in Russia began in 1903; number of associations organized subsequently is not known.

• Number organized up to 1904.

• The development of these associations has continued, but figures are not available.

• Approximate number in existence.

PURPOSE AND PLAN OF THE ASSOCIATIONS.

. The primary purpose of the cow-testing movement was to obtain records of the yearly production of milk and butter from each individual cow in the herds of the members, and with these data as a basis, by the selection of the best producing cows for breeding purposes, to develop a strain of cows which would produce a large quantity of milk rich in butterfat. Later it was found that to judge the quality of the individuals it was necessary in addition to keep account of the amount of feed consumed by each cow, in order to learn which of them utilized the feed to the best advantage. Many of these associations do not take into consideration the cost of the feed nor the price of products, but use the feed-unit system for this determination. By the feed-unit system the nutritive values of all feeds are reduced to a common basis, and that cow is considered best which combines the greatest yield of milk per 100 feed units with the largest production of butterfat.

It was not long before the work was extended to include also the cost of feeding and raising calves and young stock, of producing pork, and of keeping horses. It has even been extended to the keeping of records of yields of different fields with different crops, and much good has thus been accomplished, as the records furnish a good basis for comparing different systems of farm management, cultivation, crop rotation, etc.

The cow-testing associations of Denmark have on an average 22 members each and 390 cows. Each association employs an expert dairyman to make periodical visits to the farms of the members. At each visit he remains twenty-four hours, and obtains records, by actual weighing and testing, of the amount of feed consumed by each animal and the amount of milk and butterfat each cow yields during the twenty-four hours he is at the farm. With these data as a basis, he calculates the amount of feed each cow consumes for the entire year, as well as the amount of milk and butter she produces.

In case the association keeps records of other animal production, the cow tester obtains from the farmer information with reference to the amount of feed consumed by each animal, thus ascertaining the feed cost of keeping the animal; and by making occasional weighings of the animal the cost of producing 1 pound of gain is determined. Where records are kept of the growing of crops the cow tester ascertains from the farmer the total yield of a crop, as well as the total acreage, and calculates the yield per acre. If the grain has been sold, receipts must be shown for its delivery. By applying the total sum of expense in connection with the growing of the crop the cost of producing 1 bushel is calculated.

IMPROVEMENT AS SHOWN BY RECORDS.

Records of the first year's work of the cow-testing associations are not obtainable, but the method soon grew so much in importance and popularity that it was recognized by the Government and appropriations were made for promoting it. This assistance made it possible to collect the records of the various associations. Many of these records show very decided increases in average yield, and they furnish interesting material for study.

The following table shows the improvement in a herd owned by Mr. August Kinch at Beltagera, Sweden:

Record of a dairy herd in Sweden.

Testing period (365 days).	Average number of cows in herd.	Average milk yield per cow.	Average fat test of herd.	Average butter yield per cow.	Average feed units con- sumed per cow.*	100 feed units gave—		Cost to pro- duce 100 pounds of milk.	Cost to produce 1 pound of butter.
						Milk.	Butter.		
		<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>		<i>Lbs.</i>	<i>Lbs.</i>	<i>Cents.</i>	<i>Cents.</i>
1899-1900.....	70	7,320	3.05	245	2,421	302	10.1	86.0	25.7
1900-1901.....	28	7,905	3.13	272	2,696	293	10.1	88.6	25.7
1901-2.....	46	9,008	3.20	317	2,566	350	12.3	74.1	21.1
1902-3.....	55	9,984	3.18	350	2,507	398	18.9	65.3	18.6
1903-4.....	61	10,584	3.22	376	2,587	407	14.5	63.5	17.9
1904-5.....	64	11,236	3.22	399	2,743	409	14.5	63.5	17.9
1905-6.....	71	11,833	3.21	401	3,035	372	13.2	69.6	19.7
1906-7.....	79	11,486	3.18	408	3,111	369	13.0	70.4	20.1
1907-8.....	77	11,023	3.17	385	3,075	358	12.5	72.5	20.8
1908-9.....	79	11,399	3.34	421	3,051	374	13.8	69.6	18.8
Increase(+) or decrease(-)		+4,079	+0.29	+176	+630	+72	+3.7	-16.4	-6.9

* One Swedish feed-unit equals—1 kilogram (2.2 pounds) mixed grain; 1.2 kilogram (2.6 pounds) dried beet pulp; 1 kilogram (2.2 pounds) gluten feed; 2.5 kilograms (5.5 pounds) hay; 1.1 kilograms (2.4 pounds) wheat bran; 4 to 6 kilograms (9 to 13 pounds) straw; 0.9 kilogram (2 pounds) linseed cake; 6 to 10 kilograms (13 to 22 pounds) green clover; 0.8 kilogram (1.8 pounds) cotton-seed cake; 11 to 15 kilograms (24 to 33 pounds) turnips.

Mr. Kinch joined the cow-testing association in 1899. It will be noticed that he had 70 cows. The first year's testing revealed the fact that only 28 of them possessed sufficient merit to be deemed fit for breeding purposes, and the remainder of the herd was disposed of. The heifers of these 28 cows were raised and added to the herd, which kept increasing in numbers until in the seventh year it contained one more cow than in the first year. The increased yields shown in this table were accomplished by the selection of cows of large and economical production, and their progeny, combined with the use of improved sires. Naturally, with increasing production, the cows consumed more feed, something an owner can look at with satisfaction when he sees, as in this case, a gradual increase in yield per 100 feed units and a correspondingly satisfactory decrease in the cost of production. Assuming a cost of 2.6 cents for each feed unit and a price of 30 cents a pound for butter, the extra clear profit from 70 cows the last year was \$2,549.40 more than it was the first year, when

Mr. Kinch joined the cow-testing association. The cost of obtaining these records was less than \$1 per cow, or less than \$70 a year; and, assuming that the cost of purchasing good sires was offset by the increased commercial value of the herd, it means that an outlay of less than \$70 a year brought an income of \$2,549.40.

Assuming that the profit from the cows could be applied to pay off the mortgage on a farm, a man with a herd of 70 cows like those owned by Mr. Kinch in 1900 could pay off a mortgage of \$10,000 in 29 years; while the profits from 70 cows such as those owned by Mr. Kinch in 1909 would pay this mortgage in less than four years.

The following table shows the result of ten years' testing in the Lundatrakten Cow-Testing Association in Sweden:

Record of a Swedish cow-testing association for ten years.

Year.	Average milk yield per cow.	Average fat test.	Average butter yield per cow.	Average number of feed units per cow.	100 feed units gave—	
					Milk.	Butter.
	Pounds.	Per cent.	Pounds.		Pounds.	Pounds.
First year.....	6,890	8.11	286	2,586	266	9.1
Second year.....	6,582	8.11	225	2,468	268	9.1
Third year.....	7,857	8.16	256	2,501	294	10.2
Fourth year.....	7,692	8.17	268	2,418	319	11.1
Fifth year.....	7,653	8.04	256	2,281	336	11.2
Sixth year.....	8,268	8.04	277	2,443	338	11.3
Seventh year.....	9,156	8.05	307	2,608	362	11.8
Eighth year.....	9,338	8.15	324	2,648	353	12.3
Ninth year.....	9,183	8.15	319	2,585	355	12.3
Tenth year.....	10,064	8.12	345	2,751	366	12.6
Increase.....	3,174	.....	109	165	100	3.5

This association had in the tenth year 639 cows. Giving the butter a value of 30 cents a pound and the feed units a cost of 2.6 cents a unit, these 639 cows returned during the tenth year \$18,153.99 more than the same number would have returned during the first year, or nine times as much net profit. The cost of this splendid added income is less than \$1 per cow, or less than \$639 a year.

The cow-testing records in Denmark and Sweden show other instances where equally great improvements have been accomplished by profiting by the lessons the records teach. To duplicate the improvement shown in the foregoing table is indeed a worthy object for any cow-testing association.

THE COW TESTERS.

The cow testers (the men who collect the data and make the calculations) are young men who have been trained for this purpose. The agricultural schools have organized courses for the education of these men. One of the conditions for entrance to the schools is that the young men must have been raised on the farm and have had prac-

tical experience in the feeding and care of live stock. At the conclusion of this training, followed by one or two years' work in a cow-testing association, these men are greatly sought after for positions of trust and skill in connection with the dairy business. They can be found as managers and owners of dairies and operators of creameries, and so well recognized is the effect of this training that many creameries and dairies specify in their advertisements for men to fill these positions that the men must have had such training.

GENERAL RESULTS IN EUROPE.

Reports from Denmark show that the average production per cow in 1908 had increased to 224 pounds of butter. This average is exactly twice as much as it was in 1884. Much of this improvement has been accomplished as a result of the cow-testing movement. Reports from Sweden show an equal improvement. The more indirect results are seen in better system for all farm work, a livelier interest in the business of the farm, and a better understanding of the technical problems connected with its management. On the whole, the cow-testing associations have had a powerful influence in interesting the young people in farm life and keeping the population in the rural districts, and during the later years large farms are being cut up into smaller farms, in order that they may furnish homes for all the people desiring to engage in agricultural pursuits.

ASSOCIATIONS IN THE UNITED STATES.

OPPORTUNITY AND NEED.

According to the Twelfth Census the average production of butterfat per cow in the United States in 1900 was 145 pounds, which compared with the average production of 224 pounds of butter per cow in Denmark is entirely too low. The Bureau of Statistics of the Department of Agriculture reports that on January 1, 1910, there were 21,801,000 milch cows in the United States, and if it were possible to inaugurate a system whereby the average production per cow might be increased even 1 pound of butterfat in a year, this increase would amount to 21,801,000 pounds, which at the price of 30 cents a pound would be worth \$6,540,300. If such an increase could be brought about by better selection of cows and feeding stuffs, the sum mentioned could be figured practically as clear profit. Investigations by experiment stations and breeding associations show that there are a large number of cows which yield greatly in excess of this average, some reaching an amount as high as 800 or 900 pounds of butterfat in a year—one cow even 998 pounds. This being the case, there must be a large number of cows which yield less than 145 pounds of butterfat in a year.

Many reports of cow census investigations conducted by Hoard's Dairyman have been published during the last decade. These investigations have been made in representative sections of many dairy States, and show an average production but very little above that reported in the Twelfth Census. More than one-fourth of the herds reported failed to produce enough milk or butterfat to pay for their feed at market prices.

THE PRACTICAL DIFFICULTY.

The difficulty has been to devise a system whereby the unprofitable cows might be detected. It is a common belief among farmers that the man who does the milking knows the best cows in the herd, as well as the poorest; but numerous experiments have demonstrated clearly that this belief is not warranted. Many factors enter to lead the judgment astray. The cow which gives a generous flow of milk during the first few weeks of her period of lactation is usually regarded as the best cow. She may soon go down in her flow of milk, and perhaps goes dry for four or five months of the year, but this is not observed, and only the memory of the large flow she gave when fresh lingers in the mind of the owner.

Another cow may give only a fair flow of milk when she first comes in, and may not be regarded highly by her owner; but she may continue at the same rate of yield for a long period, and will in the end prove a great deal more valuable than the other cow. No milker can tell, without weighing the milk regularly, whether a cow gives 6,000 or 8,000 pounds of milk in a year; still the difference may prove the difference between profit and loss on that particular cow.

When the milk is valued according to its butterfat content unsupported estimates of the cow's performance are still more uncertain. It requires frequent testing to ascertain the average percentage of fat in the milk a cow yields; the test may vary greatly from milking to milking and from day to day. There may also be a great variation in the richness of the milk yielded by a cow when she is fresh as compared with a time later in the period of lactation.

And last, but not least, different cows show different feed requirements for the same production of milk or fat—a fact which is not generally thought of, and it is impossible for the feeder to estimate accurately the difference in cost of feeding the various cows for a year unless records of the feed are kept systematically.

An expression often heard among members of cow-testing associations during the first year is, "The cow I thought was my best cow is actually the poorest," which shows that impressions of the relative profitableness of the different cows in the herd, if formed without actual records, may be exactly contrary to the truth.

It is possible for the farmer, by weighing, to ascertain the amount of milk that each cow in the herd produces, and ever since the invention of the Babcock test he has had an easy means of knowing the fat content of the individual cow's milk. Very few farmers, however, have taken advantage of this opportunity; not because it would not pay them to do so, but largely because testing is tedious work, and requires care, regularity, and time to make it accurate. Many farmers have bought Babcock testers and have started in to do this work, but have given it up for the above reasons. It has the nature of an extra chore, and is apt to be neglected under the pressure of other work. To be successful, a system for obtaining these data must be independent of other work on the farm.

THE ELEMENTS OF ECONOMY.

In order to be able to decide intelligently which cows produce milk and butter economically and which do not, it is necessary to know three things about the individual cows in the herd. First, how much milk they give; and this must be known for a year, because a cow has to be fed for three hundred and sixty-five days. Second, how much butter fat there is in each cow's milk, for upon this depends the market value of the milk. And third, in order to form a correct idea as to the economical utilization of the feed, it is necessary to know the amount of feed consumed by the cow.

The cow's ability to convert feed into dairy products economically can not always be judged by net profit in dollars and cents, as this profit is dependent also upon the skill of the feeder and the sagacity with which he selects low-priced and at the same time suitable feeding stuffs. In other words, the same cow might yield very different results with different owners; therefore, in judging of net profits, the man as well as the cow should be considered. For this reason, cows in one herd should not be compared on this basis alone with cows in another herd, nor should the summaries of whole herds be thus compared. The product must be compared with the feed consumed in order to form an accurate opinion, and that cow is a good dairy cow which has the ability to convert a large amount of feed into a correspondingly large amount of valuable dairy products with the least waste. In the absence of any such system as the feed-unit system, whereby all feeds are brought to a common basis regardless of their cost, it is perhaps not practicable to express absolutely the exact degree of economy in the production of dairy products.

The dairyman usually fixes a certain quantity of butterfat as a minimum, and if a cow does not reach that production she is deemed undesirable and disposed of. The cow tester's duty is to study the

individuality of each cow in the herd and teach the farmer to feed her so that she will reach her maximum production consistent with an economical utilization of the feed.

THE FIRST AMERICAN ASSOCIATION.

The cow-testing movement in the United States was inaugurated by the writer, working under the direction of the State dairy and food department of Michigan, and the first association was organized at Fremont, Mich., September 26, 1905, under the name of the Newaygo County Dairy Testing Association. The general purpose for which it was formed was "to promote the dairy interests of its members, and particularly to provide means and methods for testing the milk of the cows of the members periodically." It consisted of 31 members, and 239 cows completed the first year's test. The officers of the association consisted of a president, a vice-president, a secretary and treasurer, and a board of nine directors. This board had the management of the business of the association and employed a cow tester, who made monthly visits to each herd, and as there are only twenty-six working days in a month, it was necessary for him in some cases to test two herds in one day.

METHODS OF OPERATION.

The cow tester arrives at the farm in the afternoon and remains there for twenty-four hours, when he is carried by the farmer to the farm of the next member in the association.

On his arrival at the stable the cow tester enters in a book which he carries for this purpose the name and number of each cow in the herd, whether she gives milk or not. As it is the purpose of the work to ascertain the actual status of the whole herd, as well as of the individual, every cow in the stable should be entered on this list. It is obvious that if only cows with large yields were entered on the list, at the end of the year the herd would show a higher average than the truth would warrant. For this reason, and in hope of obtaining commercial advantages from such high records, some dairymen have preferred not to have the whole herd tested; but it is a rule of the cow-testing association to obtain records of every animal in the herd which has had one calf, and no records are published where such is not the case.

The cow tester takes part in the feeding of the cows, and while doing so he weighs the amount of roughage and grain each cow receives and records these data in a book which he carries with him at all times. The milk yielded by each cow is weighed and samples of it are obtained for testing. Records of the feed and the yield for each

individual are again obtained and recorded the next morning, and after breakfast the fat determination is made. During the forenoon the calculations are made and entered in the record book, which at all times remains in the possession of the farmer.

The milking is done at the usual milking time, in order that the average yield may be obtained as accurately as possible. In case of competition between the herds, there may be a tendency to milk early in the morning on the day the tester is expected to arrive. In this way the yield for the testing day might be somewhat increased. To guard against this it is customary in some associations for the cow tester not to follow a regular route, so that it will be impossible for the dairyman to know the exact day on which to expect him.

In weighing the milk a "shotgun" can—a can 8 inches in diameter and 20 inches high—is used. It holds 35 pounds and has straight sides, with a handle near the bottom so that it may be easily emptied. The empty can should weigh even pounds so that mistakes in subtraction may be avoided. It has straight sides so that accurate samples may be obtained by the use of an instrument known as a "milk thief," as with an ordinary milk pail with a flaring top an accurate sample might not always be obtained, owing to the greater area of the milk at the surface than at the bottom. If the herd is large it is desirable to have two of these cans with straight sides so that the milker may pour the milk into them and proceed to milk the next cow without waiting for the tester to weigh and sample the milk. In this way time is saved in the stable.

For weighing the milk a special spring balance is used, weighing to 30 pounds and having two indicators, one of which is adjustable and should be set at zero when the weigh can is on the scales. The balance is graduated in tenths of pounds and is frequently tested so that any stretching of the spring may be immediately detected. The milk is poured from pail to pail two or three times and the sample for testing is taken immediately after such pouring is completed.

The fat determinations are invariably made at the farm. The reason for this is the difficulty in transporting the samples to the creamery without leakage, churning of the milk in hot weather, etc., any of which renders correct determination difficult. Another and equally important reason is that the dairyman becomes more interested in the work if it is done on the farm. He usually assists the expert with the testing and in this way acquires an understanding of the principles and the use of the Babcock test which he would not otherwise get.

If a cow is in heat or temporarily out of condition on the testing day, no sample of her milk is taken, as there is usually an abnormal fluctuation in the fat content at such times, and the calculations based

upon tests taken then may be several pounds too high or too low. The fact of such temporary abnormal condition is recorded in the herd book, and the average of the preceding and the following months' tests is used in the calculations.

Milk from fresh cows for the first three days can not be considered normal, and calculations based upon a test at that time may be very erroneous. It is the rule not to use the test of a cow's milk for calculations until she has attained a normal condition. If she has not reached this condition on testing day the following month's test is used as a basis for calculation. The yield for the first three days is omitted from the record, and the cow is considered as being dry when nearing the end of the lactation period.

The day upon which the test is made is called the testing day, and the records obtained on that day are used as a unit for each day in the period extending equal lengths of time on both sides of the testing day. This period is called the testing period, and is so marked off as to end exactly in the middle of the time between two testing days. Observance of this rule is very important, as it materially affects the accuracy of the work. The number of days in the testing period is understood to include both the dates mentioned as beginning and end of the period; thus, if the testing period begins March 15 and ends April 14, there will be thirty-one days in the testing period. The yields of milk and butterfat for the testing period are found by multiplying the yield on the testing day by the number of days in the period. The daily yield of milk is recorded in tenths and the monthly yield in whole pounds, while the yield of butterfat is recorded in tenths of a pound. If 12 tests are made in the year, 12 testing periods will result, and the sum of the records thus obtained will furnish a total summary of the various items for one year.

It is always advisable that the dairyman should make daily weighings of each cow's milk. By doing this he will discover at once any sudden fluctuation in the milk yield, and may in many cases be able to locate and remedy the cause. He should also note when each cow goes dry, when she is bred, the date of calving, and any changes in feed during the testing period, so that he may be able to give the cow tester this information when he arrives.

A MICHIGAN ASSOCIATION'S RECORD FOR THE FIRST FOUR YEARS.

The Newaygo County Dairy Testing Association, the first cow-testing association organized in the United States, has now been in operation for more than four years, and four whole years' records have been obtained. At the end of the first year a number of members withdrew from the association, but new members were readily found,

and the association is now able to get more members than it can take care of. The summaries for the first four years of the association's existence are given in the following table:

Yearly averages per cow of Newaygo County (Mich.) Dairy Testing Association.

Year.	Number of cows.	Milk.	Fat test.	Total butterfat.	Value of fat per pound.	Total value of fat.	Cost of roughage.	Cost of grain.	Total cost of feed.	Profit.	Returns for \$1 expended in feed.	Feed cost of 1 pound butterfat.	Feed cost of 100 pounds milk.
		<i>Lbs.</i>	<i>P. ct.</i>	<i>Lbs.</i>	<i>Cts.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Cts.</i>	<i>Cts.</i>
1906.....	239	5,396	4.04	215.0	23.3	50.27	20.92	8.86	29.28	20.99	1.72	13.6	56
1907.....	287	5,467	4.02	219.7	29.1	63.85	24.88	11.54	36.42	27.43	1.76	16.6	67
1908.....	254	6,007	4.21	252.8	27.3	68.99	25.60	14.07	39.66	29.33	1.74	15.7	66
1909.....	272	6,170	4.28	264.5	31.2	82.43	27.04	14.95	41.99	40.44	1.96	15.9	68

The following table gives the yearly averages of nine herds which were in the association from the beginning:

Yearly averages per cow of nine herds for four years.

Year.	Number of cows.	Milk.	Fat test.	Total butterfat.	Value of fat per pound.	Total value of fat.	Cost of roughage.	Cost of grain.	Total cost of feed.	Profit.	Returns for \$1 expended.	Feed cost of 1 pound butterfat.	Feed cost of 100 pounds milk.
		<i>Lbs.</i>	<i>Per ct.</i>	<i>Lbs.</i>	<i>Cents.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Dolls.</i>	<i>Cents.</i>	<i>Cents.</i>
1906.....	70	5,802	4.01	232.7	23.5	54.66	21.52	11.71	33.23	21.43	1.64	14.3	57.2
1907.....	85	5,987	4.03	241.4	29.4	71.02	25.59	13.70	39.29	31.73	1.81	16.3	65.6
1908.....	86	6,011	4.29	258.2	27.4	70.70	24.97	15.64	40.61	30.09	1.74	15.7	67.6
1909.....	89	6,426	4.32	277.6	31.2	86.52	27.26	16.44	43.70	42.82	1.98	15.7	68.0

These tables show a continuous increase in the average production. The richness of the milk has also increased. The average profit per cow has been doubled. Some of this increase in profit is partly accounted for by the increase in the price of butterfat, although feed prices show an almost corresponding increase. In these calculations it has been assumed that the value of the calf, skim milk, and manure from each cow would offset the cost of stabling, labor, and caring for her.

METHOD OF ORGANIZING.

The usual way of organizing an association has been to ascertain the extent of the interest in dairying in a community, and to call a meeting and explain the merits of the cow-testing association as an institution. If enough interest is exhibited to warrant going on with the work, a temporary organization is effected, and the neighborhood is thoroughly canvassed during the following few days in search of

additional members for the association. When enough have been secured a second meeting is called, at which the organization is perfected, officers elected, and by-laws adopted.

In order to support a cow-testing association it is necessary that there should be 26 herds, conveniently located, and a sufficient number of cows so that the tester can get a reasonably good salary. As it is each member's duty to furnish the tester's conveyance to his next place of work, it is necessary that the farms of the members be located near enough together so he can be conveyed without inconvenience. A distance of 2 miles is not too great to give satisfaction, and the conveyance is often furnished by some passer-by. If the cow tester keeps his own horse and buggy, as is the case in some associations, a larger territory is usually accommodated. In such cases the members must furnish feed and stabling for his horse. The charge to the farmer is usually \$1 a year for each cow. This money constitutes the pay of the tester; and it is desirable that there should be not less than 400 cows in an association, in which case the tester gets \$400 a year. In addition he gets his board and lodging free of charge at the farm where he is working. There being only twenty-six working days in a month, it is not possible to have more than 26 members, except in cases where two men with small herds live very close together so that it is possible to test both herds in one day. On such farms the regular milking time is fixed so that the tester can attend to the weighing and testing in the first herd and still have plenty of time to get to the second herd by the regular milking hour. In addition to the \$1 a cow, the farmer pays a membership fee of 25 cents yearly. This money, which for 26 members amounts to \$6.50, is used for paying incidental expenses, postage, cost of sulphuric acid, etc.

THE TESTING OUTFIT.

A testing outfit consists of a 12-bottle Babcock tester with glassware, two "shotgun" cans in which to weigh the milk, a spring balance, a "milk thief," and the necessary books and record blanks. The outfit, with the Babcock tester, is usually furnished by the State authorities, but in case it must be purchased by the association assessments have to be levied for this purpose unless the number of cows is great enough so that it can be paid for out of the fund collected at the rate of \$1 a cow. The necessary books and blanks have in some cases been provided by the United States Department of Agriculture until such time as the States have appropriations from which to supply these. The States of Michigan, Wisconsin, Vermont, Ohio, Iowa, and Maine now have provision for supplying this material to associations within their own borders.

QUALIFICATIONS OF THE TESTER.

The cow tester has much to do with the successful working of an association. He should be well fitted temperamentally and should have had special training for the work. Punctuality, regularity, and accuracy are of great importance, for unless he has these qualities the records may not be a true indication of the value of the respective cows. The tester should also have the ability to advise and teach the farmers, and for this reason it is necessary that he be constituted temperamentally to give advice in such a manner that it will be accepted and followed.

The work of a cow-testing association depends largely for its success upon the capability, reliability, and conscientiousness of the tester; but, on the other hand, the result of this work depends also upon the members. They should be willing to profit by the lessons which the cow testing teaches and ready to put into effect such changes in feed, stabling, and operation of the dairy as the records show will be profitable.

In this country, as well as in Europe, the position of cow tester offers excellent opportunities for dairy students to gain practical experience and is the best kind of school to fit them for responsible positions in connection with dairy work.

ACCURACY OF RESULTS OBTAINED BY VARIOUS TESTING METHODS.

Through the kindness of Prof. T. L. Haecker, access was had to the records kept of the production of the herd at the Minnesota State Experiment Station, St. Paul, Minn., where weights and Babcock tests of every milking of each cow in the herd have been recorded for nearly twenty years. The accuracy of the method used by the cow-testing associations was determined by comparing the yields as estimated by them and outlined in this publication with the actual yields as determined by weighing and testing each milking.

The accuracy was also determined of the estimated yearly yields as calculated by each of the following methods: (1) Taking the weights and a test of the composite sample of eight milkings in the middle of each month; (2) taking the same for four milkings in the middle of each month; (3) taking the product of one day in the middle of each three-week period; (4) taking the product of one day in the middle of each two-week period. In each of these methods the yields for each period were estimated and the sum of the periods was taken as the total for the year.

The following table shows the variations from the actual yields obtained by each of these five methods, the percentages of difference above or below the actual yields being shown in each case. The maximum variation by the cow-testing association method was not

over 5.1 per cent for any one year, and this method compares favorably for accuracy with any of the others. The table shows the maximum per cent of variation for any one year and the per cent of total difference from the actual yield for nine years for each of the methods.

Variations from actual yield of estimated yield of milk and butterfat as determined by various methods.

	Milk.					Butterfat.				
	Cow-testing association method.	Eight milk-ings; com-posite.	Four milk-ings; com-posite.	One day in three weeks.	One day in two weeks (five years).	Cow-testing association method.	Eight milk-ings; com-posite.	Four milk-ings; com-posite.	One day in three weeks.	One day in two weeks (five years).
Cow 1:	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Maximum variation	-3.3	-2.5	+3.1	-2.7	-1.6	+2.8	+3.2	+3.6	-4.6	-1.9
Total difference	- .9	- .6	- .8	- .5	- .6	+ .3	- .8	- .7	- .8	-1.2
Cow 2:										
Maximum variation	+2.1	-2.3	-2.3	-2.9	-1.7	+2.9	+3.5	+3.9	+5.6	-3.1
Total difference	- .8	- .9	- .8	-1.0	- .8	- .8	± .0	+ .6	+ .3	-1.8
Cow 3:										
Maximum variation	-4.9	-3.2	-3.8	-2.3	-2.7	+2.9	-3.8	-3.9	+5.7	-3.9
Total difference	- .8	- .9	- .8	- .3	-1.5	-1.1	-1.4	- .6	- .4	-2.7
Cow 4:										
Maximum variation	+2.6	-1.9	-2.6	-2.6	-3.3	-4.2	-4.3	-5.3	+4.4	-4.8
Total difference	- .1	- .4	- .5	- .5	-1.9	- .2	- .5	- .7	+ .7	-2.7
Cow 5:										
Maximum variation	-3.7	- .9	-2.8	-3.8	-5.2	-5.1	+2.9	+4.4	-3.2	-3.0
Total difference	-1.2	- .3	-1.0	-1.3	-1.6	± .0	- .4	-1.1	- .4	-1.2
Cow 6:										
Maximum variation	-3.9	-3.3	-3.8	-4.5	-1.8	-4.8	+3.5	-3.9	+4.3	-1.6
Total difference	-1.1	- .9	-1.1	± .0	- .3	- .6	- .5	- .5	+1.2	- .4
Cow 7:										
Maximum variation	-4.3	-4.0	-4.5	-3.8	-2.0	-4.5	-3.3	-6.1	-5.1	-2.7
Total difference	-2.0	-1.2	-1.8	- .6	-1.3	-1.7	- .9	-1.3	- .7	-1.5

In the method used by the cow-testing associations the total difference for a nine-year period is in no case over 2 per cent from the actual yield.

When we consider that the cow-testing association method means the weighing and testing of the milk just one day a month, and that the results are as close to the actual as above stated, we must conclude that the records of performance as found by the cow-testing association method are sufficiently accurate to enable the dairyman to weed out his unprofitable cows.

MEETINGS.

The associations hold monthly meetings for the discussion of topics of interest to dairymen. A programme committee selects from the members one or two to lead in the discussion, and occasionally outside speakers are invited. The meetings are usually held at the homes of the members and often take the form of a picnic. On such occasions there is free discussion and many valuable ideas are exchanged. After lunch a tour is made of the farm, and the crops as well as live stock and buildings are inspected.

GROWTH IN THE UNITED STATES.

The following table shows the growth of the movement in the United States:

Number of cow-testing associations in the United States, 1905 to 1910.

States.	Number of associations in operation.					
	1905.	1906.	1907.	1908.	1909.	1910 (5 mos.).
Michigan	1	2	4	3	5	6
Maine.....				3	5	6
Wisconsin.....				3	10	12
Vermont.....				3	5	9
California.....					2	3
Iowa.....					2	3
Pennsylvania.....					1	2
Ohio.....					1	3
Washington.....					1	1
Colorado.....						1
Connecticut.....						1
Nebraska.....						1
New Hampshire.....						1
Oregon.....						1
New York.....						1
Maryland.....						1
Total in United States	1	2	4	12	32	52

RESULTS.

Perhaps the most important result of the cow-testing associations is the increased interest which members take in their work. Farm work, consisting as it does in large part of manual labor, is apt to become monotonous unless there is an intelligent interest in the operations and unless the farmer has something special in view. The monthly visit of the cow tester stimulates this interest; and while the primary object for which the association was organized is the selection and rejection of individual animals, the results, direct and indirect, cover a very broad field.

The tester, being an expert dairyman, not only studies the individual animals in the herd as to their capacity for utilizing feed economically, but he also assists the farmer in selecting those feeds which contain the greatest amount of food nutrients at the lowest price, thereby creating a larger net return per cow, per acre, per dollar's worth of feed, and, last but not least, per man. This larger net return per cow is brought about not only by the increased yield of the cows, but by improved economy in the conversion of feed into finished product.

One of the direct results is improved breeding. Many testing associations have proved to be forerunners of breeding associations, or bull associations, for the development of purebred cattle of breeds particularly adapted to the local conditions.

The cow-testing movement, being an organized effort for improvement, is conducive to better community spirit. At the monthly meetings problems of interest to dairymen are discussed, and this discussion often stimulates a friendly rivalry for attainment of the best results. The systematic and cooperative effort creates an interest in the growing of better forage crops and in better feeding; in more sanitary stabling and better care of the milk; it opens the eyes of the farmers to the value of system in their work, and leads to the application of better business methods.

Cooperative buying of feeding stuffs is a feature in nearly all cow-testing associations. At the monthly meetings the members place in the hands of the board of directors an order for the amount of feed stuffs they wish to buy. The aggregate of these orders often amounts to several carloads, and by buying in carload lots and for cash lower prices and freight rates are obtained. The officers of the associations study the markets for feed stuffs and are often able to take advantage of a low market. In this way business judgment is stimulated and the individual member is enabled to reap the benefit of the business judgment of his more experienced coworkers.

The work, broad as it is, has value not only for the farmer, but also for the creamery and the cheese factory, since it encourages better dairy methods at the same time that it procures larger remuneration for the dairymen. One of the causes of dissatisfaction with creameries and cheese factories has been the low average production of dairy commodities. The farmer has not had any systematic performance record of the production of his individual cows, and it is natural for him to think that some one else besides himself is responsible for the low return, and the creamery or cheese-factory manager, being the one who purchases his milk or cream, has received the blame. Many farmers have had only a half-hearted interest in dairying, because the average production of their herds has been so low that they could make but a small profit therefrom. The experience already gained in places where associations have been organized shows that with the elimination of the poor cows in the herd comes an interest in better cows and better care of the cows, and a tendency to make greater discrimination in price between good and poor animals. The introduction of better cows on the farms creates a desire for more of them, and a larger number of cows renders it possible for creameries and cheese factories to collect more milk or cream in a given territory, thus reducing the cost of collection.

The increased interest in dairying stimulates interest in dairy and kindred associations, and creates an interest in purebred stock. In the Newaygo County Dairy Testing Association, where during the first year only one man owned a purebred dairy bull, 22 such bulls were found among the herds during the second year; and while no

purebred cows at all were owned in the first year, 21 were bought during the second year. This interest has steadily increased, and during the third year a breeding association was organized. Such increased interest in purebred stock naturally affects the market for such stock, and entitles the movement to the hearty support of the breeders' associations of the different dairy breeds.

The consumer is interested not only in greater economy in the production of dairy commodities, but in improvement of their quality, which is promoted by sanitary stabling and better care of milk on the farm. These results follow from cow-testing associations wherever tried, and the consumer should for this reason give encouragement to such organizations.

RELATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE TO THE WORK.

The United States Department of Agriculture, through the Dairy Division of the Bureau of Animal Industry, has been largely instrumental in encouraging the inauguration of cow-testing associations in the various dairy States, and has always worked in cooperation with the State authorities. In many States no funds have been available for conducting the work, and the Department has furnished the services of an organizer and has supplied blanks and record books free of charge, in the hope that when the value of the work has been demonstrated the States would appropriate sufficient funds to carry it on.

Such appropriations should cover the expenses of organizing, such as salary and traveling expenses of an organizer; they should also provide for the printing of books and blanks for compilation of the records, and for publication of the same.

It is advisable that some State authority should supervise the work, and that occasional visits should be made to the associations, so that difficulties may be straightened out should they arise. It is also desirable that the supervisor of the work should attend the meetings held by the associations and give advice to the tester and check up his work, in order to get the highest degree of accuracy. Many of the States have already provided for such supervision, and for furnishing the material as well as for compiling the records, and it has been the policy of this Department to encourage the assumption of State control of the work.

In the promotion of this movement the Dairy Division has sought to forestall some of the defects under which the work in the older countries suffered during its earlier years. By furnishing the blank forms for the first few associations in each State, the aim has been to establish uniformity of methods, and by studying the work in the

various States and keeping in close touch with it, to be able at all times to suggest to those interested the latest improvements in the system.

CONTRACT USED IN THE ORGANIZATION OF A COW-TESTING ASSOCIATION.

Whereas the ——— Dairy Testing Association has been organized for the principal purpose of providing means for the cooperation of its members in testing the milk of their cows periodically and for otherwise improving their dairy interests; and whereas it is proposed by said association to engage a suitable person as soon as enough subscriptions are obtained to warrant said association in engaging such person, we, the undersigned members of said association, each for himself and not one for the other, agree to pay the sum of ——— for each cow set opposite our respective names to said association for that purpose. Said fees to be paid in quarterly installments in advance, the first payment to be made as soon as such person is engaged by said association. Each one of us also agrees to furnish board and lodging for said person for at least one day each month, and convey him to his next place of work. Said person shall not work Sundays, but shall have board and lodging over Sunday at the place where he is working Saturday.

CONSTITUTION AND BY-LAWS FOR A COW-TESTING ASSOCIATION.

ARTICLES OF ASSOCIATION.

We the undersigned, desiring to become incorporated under the provisions of act No. ——— (of the public acts of ———), entitled ———, and the acts amendatory thereof and supplementary thereto, do hereby make, execute, and adopt the following articles of association, to wit:

ARTICLE I. The name by which this association shall be known in law is ——— Dairy Testing Association.

ARTICLE II. The purpose for which it is formed is generally to promote the dairy interests of its members, and particularly to provide means and methods for improvement of the dairy qualities of cows and for the testing of the cows of its members periodically.

ARTICLE III. Its principal office and place of business shall be at ———.

ARTICLE IV. The number of its directors shall be ———.

ARTICLE V. The names of the directors for the first year of its existence are as follows: ———, ———.

ARTICLE VI. Any person may become a member of this association and be entitled to its benefits and privileges upon being accepted by the board of directors and upon complying with the requirements of the by-laws.

BY-LAWS.

ARTICLE I. *Meetings.*—An annual meeting of this association shall be held at a place to be designated by the board of directors, in ———, on the ——— day of ——— in each year, at 2 o'clock p. m., for the purpose of electing a board of directors, and for the transaction of such other business as may lawfully come before said meeting.

The president shall call one meeting each month for the purpose of discussing topics of interest to dairymen and shall at each meeting appoint a committee of three members who shall prepare a programme for the next meeting. No member shall be obliged to serve two months in succession on this committee.

BY-LAWS.

ARTICLE I. Meetings.—An annual meeting of this association shall be held at a place to be designated by the board of directors, in —, on the — day of — in each year, at 2 o'clock p. m., for the purpose of electing a board of directors, and for the transaction of such other business as may lawfully come before said meeting.

The president shall call one meeting each month for the purpose of discussing topics of interest to dairymen and shall at each meeting appoint a committee of three members who shall prepare a program for the next meeting. No member shall be obliged to serve two months in succession on this committee.

Special meetings may be called by the board of directors or by the president, and notice thereof shall be given by the secretary, by mailing to each member a written or printed notice thereof at least five days prior to such meeting. Such notice shall state the object of the meeting, and no other business shall be transacted thereat.

ARTICLE II. Board of directors.—Section 1. The board of directors shall be elected at the annual meeting, the first election to be held on the — day of —, A. D. —.

Section 2. The board of directors shall have the management and control of the business of the association, and shall employ such agents as they may deem advisable, and fix the rates of compensation of all agents and employees.

Section 3. Whenever any vacancies occur in the board of directors by death, resignation, or otherwise, the same shall be filled without undue delay by the majority vote of the remaining members of the board. The person so chosen shall hold office until the next annual meeting or until his successor is elected and qualified.

Section 4. The board of directors shall meet on the first — of each month, at such hours and in such places as they may by resolution determine.

Section 5. A majority of the board of directors shall constitute a quorum at all meetings of the board.

ARTICLE III. Officers.—Section 1. The officers of the association shall consist of president, vice president, secretary, and treasurer. The offices of secretary and treasurer may be held by the same person. The officers shall be elected by the board of directors from their own number by a majority vote of the whole number of directors. The first election shall be held immediately after the election of the board. Subsequent elections shall be held annually on the day of the regular meeting of the board next ensuing after the annual election, the day to be fixed by resolution of the board of directors.

Section 2. In case of death, resignation, or removal of any officer, the board shall elect his successor, who shall hold office for the unexpired term.

ARTICLE IV. Membership.—Any person acceptable to the board of directors may become a member upon paying a membership fee of 25 cents.

ARTICLE V. Dues.—Each member shall pay a fee of 25 cents annually on or before the — day of —; and in addition thereto shall pay quarterly dues to cover his share of the expense of cow testing, in proportion to the number of cows he has subscribed, the amount of such quarterly dues to be fixed by the board of directors, and paid as specified in a contract to be made for this purpose between the members.

Testing and record keeping of cows in addition to the number subscribed shall be paid for at the rate of \$— for each cow per year.

No member shall be allowed to participate in the election of the board of directors who shall not have paid his annual dues in advance.

ARTICLE VI. Amendments.—These by-laws may be amended or added to by a majority vote of all the members present at the annual meeting or at a special meeting called for the purpose.

656.073
2658
Brc
Issued July 22, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 180.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY
UNIV. OF MICHIGAN
SEP 5 1912

A METHOD FOR THE SEPARATION OF THE SEVEN PERMITTED COAL-TAR COLORS WHEN OCCURRING IN MIXTURES.

By T. M. PRICE, Ph. D.,
Senior Biochemist, Biochemic Division.

INTRODUCTION.

The regulations of the Secretary of Agriculture governing meat inspection allow the use of certain dyes on casings of sausages and other meat food products when the character of the casing is such that the dye will not penetrate into the meat food product contained therein. The coal-tar dyes permitted to be used for this purpose are as follows:

Red shades:

- 107. Amaranth.
- 56. Ponceau 3 R.
- 517. Erythrosin.

Orange shades:

- 85. Orange 1.

Yellow shades:

- 4. Naphthol Yellow S.

Green shades:

- 435. Light Green S F Yellowish.

Blue shades:

- 692. Indigo Disulfo Acid.

The numbers preceding the names refer to the numbers of the dyes as listed by Green.¹

To obtain desired shades meat packers often employ a mixture of dyes, and in such cases it becomes necessary to determine what colors are contained in the mixture. There is little in the literature where the question of separating mixtures of colors is considered. The chief object of most work has been to obtain methods for identifying colors when they occur in a pure form.

Rota², who has a most excellent scheme for recognizing pure colors by their chemical reactions, makes the following statement in regard to the separation of coloring matters in a mixture:

It is sometimes possible to effect the separation by treating the mixture with water or alcohol at the ordinary temperature or with the aid of heat, but as a rule extract-

¹ A. G. Green. Schultz and Julius Systematic Survey of the Organic Coloring Matters. 1904.

² A. R. Rota. Chemiker Zeitung, 1898, pp. 437-442.

ing with ether or by fixing the dye on wool or other fiber is the most promising method.

Green³, assisted by Yoeman and Jones, gives a valuable means of identifying pure colors by applying the dyestuff to animal fiber. Under the head of "Mixtures" these authors state:

It is not our intention in this paper to deal fully with the detection of mixtures. A few general principles may be mentioned here which will be found useful by those who wish to extend the scheme to such cases. If a mixture consists of two or more dyestuffs of the same chemical group, it will behave as a whole similarly to a single dyestuff, though sufficient differences will usually exist in the rate of solution or of attack by the group reagent to render it possible to distinguish or even separate the constituents.

Mulliken⁴, in discussing the identification of dyestuffs in mixtures, states that infallible rules for the isolation of individual dyes from all classes of mixtures can not be formulated. He gives, however, suggestions for analytical procedures which may be applied in certain cases. He closes his chapter on "The identification of dyestuffs in mixtures" with the following remarks:

In official laboratories where the chief concern is to determine whether colors under examination belong to a certain limited list of legally permitted dyestuffs, carefully prepared standard wool, silk, and cotton dyeings and samples of their after chromed wool dyeings should prove very helpful for purposes of comparison. One of the most valuable auxiliaries in this class of work is, however, the spectroscope. This is well illustrated by the case of the seven colors permitted in foods under the regulations of the American Federal pure-food law. Six of these colors have excellent absorption spectra. Some of the bands, it is true, overlap and interfere at certain concentrations in certain mixtures, but any of them may be identified in the presence of the others if a partial separation is first effected by the fractional dyeing or stripping procedure. One of them—Indigo Disulfo Acid—which, contrary to the general rule, is rather rapidly destroyed by heating with ammonia, can not be satisfactorily identified when present in mixtures in small proportions by the fractional stripping and dyeing processes and may therefore be easily overlooked; but it is easily detected by the spectroscope. Naphthol Yellow S, on the other hand, having no characteristic spectrum, can only be separated by fractional methods and identified by chemical tests. Hence it may easily escape observation in complex mixtures when present in small quantities, its complete separation by fractional stripping and dyeing from Naphthol Orange A being slow and difficult.

With the exception of this statement by Mulliken, the writer has been unable to find any mention in the literature of a process for the separation of the seven permitted coal-tar colors when they occur in mixtures. For a method to be of value for this purpose, it should not only enable the analyst to separate these colors so that each color may then be identified, but at the same time it should enable him to detect the presence of any prohibited color which may occur in the mixture. The identification of such prohibited color would not neces-

³A. G. Green. *Journal of the Society of Dyers and Colourists*, September, 1906, p. 236.

⁴Mulliken. *Identification of Pure Organic Compounds*. *Commercial Dyestuffs*, vol. 3, 1910.

sarily be essential, for its mere presence would be sufficient to exclude the mixture from use for coloring the casings of inspected meat-food products.

THE AUTHOR'S EXPERIMENTS AND METHOD.

The first work toward outlining a method for this separation was to make a thorough study of the solubility of the seven permitted colors in various solvents and also to determine the precipitants for each. This was followed by determining what solvents would remove the colors by agitation from acid, alkaline, and neutral solutions. After this preliminary work had been conducted, known mixtures of the seven colors were taken and attempts were made to separate each color by applying the information gained through the preliminary work. The following method was finally adopted and has proved to be a valuable means of separating the seven permitted coal-tar colors when they occur in mixtures:

REAGENTS.

It is of the utmost importance that the reagents be employed of the strength indicated below:

Ammonium sulphate solution.—A supersaturated solution of ammonium sulphate is prepared by agitating ammonium sulphate in water at steam bath temperature until the water is completely saturated. This will require several hours. The solution is then allowed to cool at room temperature and should always contain an excess of undissolved ammonium sulphate crystals. The solution should always be agitated previous to using.

Sodium chlorid solution.—A supersaturated solution of sodium chlorid is prepared in the same manner as the supersaturated ammonium sulphate solution described above. The solution should stand in contact with undissolved crystals of the salt.

Calcium chlorid solution (25 per cent).

25 grams of calcium chlorid, C. P. granulated, in
100 c. c. of water.

Dilute ammonia (1:100).

1 c. c. of concentrated ammonia in
100 c. c. of water.

Dilute acetic acid (5 per cent).

5 c. c. glacial acetic acid.
95 c. c. of water.

Stannous chlorid solution.—Dissolve 30 grams of granulated tin, free from iron, in 125 c. c. of hydrochloric acid (1.19 specific gravity); dilute to 250 c. c. and filter through asbestos. To the filtrate add 250 c. c. of hydrochloric acid (1.124 specific gravity) and 500 c. c. of water.

Acetone.

Alcohol (95 per cent).

Amyl alcohol.

Acetic ether (ethyl acetate).

Ether, sulphuric (ethyl ether).

Hydrogen peroxid (3 per cent).

PROCEDURE.

PRELIMINARY TEST.

The well-known method of scattering the powdered dyestuff upon water, alcohol, and sulphuric acid should be used to determine whether one or more colors are present.

METHOD OF SEPARATION OF THE SEVEN PERMITTED COLORS.

Approximately 0.2 of a gram of the sample is rubbed up in a mortar with about 25 c. c. of supersaturated ammonium sulphate solution, filtered, and if the filtrate is colored red the residue on the filter is washed with small portions of the supersaturated ammonium sulphate solution until the washings are no longer colored red. The filtrate and washings should contain Amaranth, together with some Naphthol Yellow S. The filtrate and washings are combined and shaken with separate portions of acetic ether until the acetic ether is no longer colored yellow. The acetic ether removes the Naphthol Yellow S, and the Amaranth remains behind in the ammonium sulphate solution. The acetic ether extracts containing the Naphthol Yellow S need not be preserved, as this color will be removed in a pure form later. The ammonium sulphate solution containing the Amaranth is shaken with acetone, which extracts the Amaranth. The acetone is then filtered to remove the excess of salt, diluted with a small amount of water, and the acetone driven off on the steam bath. The water solution is then tested for Amaranth.¹

The undissolved portion of the original sample is removed from the filter, mortar, and pestle by washing with water. This water solution is acidified with acetic acid and shaken with separate portions of ether until the ether is no longer colored. The ether will remove the Erythrosin. It is washed several times with water and finally shaken up with dilute ammonia solution. The Erythrosin is taken up by the ammonia solution. The excess of ammonia is driven off on the steam bath and the solution tested for Erythrosin. Observation should be carefully made to see that this solution when very dilute has no fluor-

¹ For the identification of all the separated colors the reactions as given by Loomis (Circular 63, Bureau of Chemistry, U. S. Department of Agriculture, 1911) should be used.

escence, as this property indicates the presence of prohibited colors having similar reactions.

The water solution which has been extracted with ether is warmed on the steam bath until all the ether is removed. It is then saturated at the steam bath temperature with sodium chlorid, cooled, and filtered through a folded filter paper 18 c. m. in diameter. This filtration should be carried out so as to keep the precipitate in the bottom of the filter. The precipitate is washed with supersaturated sodium chlorid solution until the washings are colorless. The filtrate and washings should contain Light Green S F Yellowish, Naphthol Yellow S, and possibly traces of Orange 1. They are combined and shaken with acetone, which removes the Naphthol Yellow S. This acetone solution should be washed several times by agitation with supersaturated sodium chlorid solution in order to remove any traces of green color held mechanically by the acetone. A small amount of water is added and the acetone driven off on the steam bath. The water solution is acidified with acetic acid and shaken with amyl alcohol, which removes any traces of Orange 1 that may be present. The water solution is freed from amyl alcohol by heating on the steam bath and is then tested for Naphthol Yellow S.

The solution containing Light Green S F Yellowish is evaporated to a small bulk and the residue is taken up in alcohol and filtered. This removes excess of salt. The alcohol is driven off and the solution then tested for Light Green S F Yellowish.

The precipitate on the filter that has been well washed with the supersaturated sodium chlorid solution should contain Orange 1, Ponceau 3 R, and Indigo Disulfo Acid. This precipitate is dissolved in water and shaken with several successive portions of acetic ether. Orange 1 is taken up by the acetic ether. It is not necessary, however, to continue this extraction with acetic ether until all of the Orange 1 is removed. About three extractions will remove enough Orange 1 to make all the necessary tests for this color. The acetic ether portions are combined and washed with supersaturated sodium chlorid solution several times or until no more color is removed. Now shake with water; this removes the Orange 1 from the acetic ether. The water solution is freed from acetic ether by heating on the steam bath, and is then used to identify the color.

The water solution containing Ponceau 3 R, Indigo Disulfo Acid, and any Orange 1 not removed by the acetic ether is warmed on the steam bath until free from acetic ether. It is cooled, made up to 125 cubic centimeters with water, about 40 cubic centimeters of 25 per cent calcium chlorid solution added, and allowed to stand about 15 minutes. Ponceau 3 R and some Indigo Disulfo Acid are precipitated. Fifteen cubic centimeters of stannous chlorid solution is added and

stirred until all the blue color disappears. It should then be filtered immediately, as too long standing will destroy Ponceau 3 R. Ponceau 3 R remains on the filter paper. Wash with calcium chlorid solution until the blue that may have become reoxidized during filtration is washed out; dissolve in dilute ammonia solution; drive off the excess of ammonia, and test for Ponceau 3 R.

The filtrate, which should be practically colorless, is treated with hydrogen peroxid. If Indigo Disulfo Acid is present the solution will become deep blue in color.

The following table gives an outline of the above-described method of separation. It is desirable in carrying out this separation to follow the table, referring from time to time to the description included in this paper, as well as to the well-known reference works. Analysts who contemplate applying this method to the separation of mixtures of colors should first familiarize themselves with the method and with the behavior of the permitted colors by attempting the separation of mixtures of known permitted colors. It will probably be simpler to begin with two or three colors and finally to apply the method to a mixture containing all seven. Once this preliminary work has been done, the analyst will be able to detect the presence of interfering dyes. The presence of an unpermitted color will be indicated by the effect on the reactions of the permitted colors with standard reagents, and the unpermitted color may also interfere materially with the scheme of separation as outlined above.

While the method is not regarded as entirely free from defects, it has been found to give excellent results in the hands of men unskilled in color work, and it is described now with the hope that it may be of service to analysts who have been confronted with problems similar to those of the Bureau of Animal Industry.

Scheme for separating the seven permitted coal-tar colors.

Rub approximately 0.2 gram of sample in a mortar with supersaturated $(\text{NH}_4)_2\text{SO}_4$ solution until washings are no longer colored red.

Filtrate contains Amaranth and small amount Naphthol Yellow S. Shake with acetic ether.	Residue contains Erythrosin, Naphthol Yellow S, Light Green S F Yellowish, Orange 1, Ponceau 3 R, and Indigo Disulfide. Dissolve in H ₂ O, acidify with CH ₃ COOH, and shake with ether.			
(NH ₄) ₂ SO ₄ solution contains Amaranth. Shake with acetone, which removes the Amaranth. Dilute with H ₂ O and drive off the acetone.	Ether contains Erythrosin. Wash with H ₂ O and then shake with dilute NH ₄ OH, which removes the Erythrosin. The excess of NH ₃ is then driven off.	H ₂ O solution is freed of ether and saturated with NaCl on steam bath, cooled, filtered, and washed with supersaturated NaCl solution until washings are colorless.		
		Filtrate contains Light Green S F Yellowish and Naphthol Yellow S. Shake with acetone. Separate acetone and salt solution.	Precipitate is dissolved in H ₂ O and shaken three times with acetic ether.	
		Acetone removes Naphthol Yellow S. Wash with supersaturated NaCl solution; add H ₂ O to the acetone, and drive off the acetone on steam bath. Acidify with acetic acid; shake with a methyl alcohol, which removes any traces of Orange 1 present, and then test the acidified water solution for Naphthol Yellow S.	NaCl solution contains Light Green S F Yellowish. Remove excess of salt by evaporating and taking drive off alcohol and test for Light Green S F Yellowish.	Acetic ether contains Orange 1. Wash with supersaturated NaCl solution and then shake with H ₂ O, which takes out the Orange 1.
				The H ₂ O solution is warmed on steam bath until free from acetic ether, cooled, made up to 125 c. c. with H ₂ O, 40 c. c. of 25% CaCl ₂ solution added, and allowed to stand about 15 minutes; 15 c. c. of SnCl ₄ solution added and stirred until the blue color is destroyed. Filter.
				Filtrate contains Indigo Disulfide. It is treated with H ₂ O, which should give a deep blue color if Indigo Disulfide is present. The excess of NH ₃ is then driven off.
				The precipitate contains Ponceau 3 R. It is washed with CaCl ₂ solution until free from blue color. Dissolve in dilute NH ₄ OH. The excess of NH ₃ is then driven off.
Amaranth.	Erythrosin.	Naphthol Yellow S.	Light Green S F Yellowish.	Orange 1.
				Indigo Disulfide Acid.
				Ponceau 3 R.

Approved:
 JAMES WILSON,
Secretary of Agriculture.
 WASHINGTON, D. C., June 5, 1911.

656. 673
U58
B95c

Issued November 1, 1911.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 181.

A. D. MELVIN, CHIEF OF BUREAU.

METHODS AND RESULTS OF PARAFFINING CHEESE.

BY

C. F. DOANE,

Assistant Dairyman. Dairy Division.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; R. A. RAMSAY, MORRIS WOODEN,
and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

DAIRY DIVISION.

B. H. RAWL, *Chief.*

HELMER RABILD, *in charge of Dairy Farming Investigations.*

S. C. THOMPSON, *in charge of Dairy Manufacturing Investigations.*

L. A. ROGERS, *in charge of Research Laboratories.*

GEORGE M. WHITAKER, *in charge of Market Milk Investigations.*

ROBERT MCADAM, *in charge of Renovated Butter Inspection.*

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., August 11, 1911.

SIR: I have the honor to transmit herewith, and to recommend for publication in the circular series of this bureau, a manuscript entitled "Methods and Results of Paraffining Cheese," by Mr. C. F. Doane, assistant dairyman in the Dairy Division.

The paraffining of cheese has been found to be of considerable value in preventing loss in weight and the growth of mold. In this paper the author reports experiments indicating the methods and conditions under which the best results have been obtained. The conclusions are summarized at the end of the paper.

Earlier work of the Dairy Division relating to this subject has been reported in Bulletins 49, 83, and 85 of this bureau.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
The object of paraffining.....	5
Development of the process.....	6
Construction of tanks for paraffining.....	6
Previous experimental work.....	7
Plan of present work.....	8
Shrinkage in cheese as affected by the age at which paraffined.....	8
Quality of the paraffin coat as affected by time of dipping and temperature of paraffin.....	10
Results of paraffining from the press.....	12
Results of paraffining at three days.....	13
Results of paraffining at seven days.....	14
Influence of length of immersion.....	14
Effect of keeping cheese in warm room after paraffining.....	15
Amount of paraffin used at different temperatures.....	15
Summary.....	16

METHODS AND RESULTS OF PARAFFINING CHEESE.

The practice of paraffining cheese is of comparatively recent date. We have no record of who was the first to introduce it, but it was about 10 years ago that it was brought to the attention of cheese handlers, and about 6 years since it became a general practice to use a coating of paraffin to protect cheese. At the present time nearly all cheese of the Cheddar type made in the United States is paraffined at some stage before it reaches the consumer.

THE OBJECT OF PARAFFINING.

Cheese was first paraffined on a large scale in order to improve its appearance. A green mold appears quickly on cheese that is not constantly handled and treated in some manner to prevent its growth. When cheese has been stored for any length of time without the necessary attention its surface presents a very uninviting appearance. It was customary for the large dealers to scrape the surface before it was shipped to the retail dealer or placed on the counter to sell to the consumer. This required much labor and resulted in a considerable loss of the cheese, as a very appreciable amount was scraped off while removing the mold.¹

Soon after the practice of paraffining became general it was found to have an even more important economic effect than improving the appearance. Formerly there had been considerable losses in stored cheese due to the evaporation of the contained moisture, and it has since been proved that this evaporation did not in any way add to the value of the product by improving its quality. It was found that the protecting coat of paraffin to a great extent prevented this evaporation and the consequent loss. The actual saving by paraffining is about 3 per cent of the gross amount of cheese made, which would amount to a very large sum of money when all of the cheese of the Cheddar type made in the United States is considered.

¹ Exporters report a prejudice against paraffining still existing among a large proportion of English dealers and consumers, who want the cheese with the mold on, although there can be no question of the improved appearance of the product as a result of paraffining.

DEVELOPMENT OF THE PROCESS.

Cheese was first paraffined on an extensive scale by dipping it into paraffin that had been melted and heated over a direct flame or in a bath of hot water. No material change from this original process has yet been made. There has been a natural evolution in styles of vats and in the apparatus for handling the cheese rapidly, but the apparatus is necessarily very simple even in the most modern plants. Very little attention has been paid to the effects of different temperatures of the paraffin at the time the cheese is dipped, and no uniform temperature has been advocated or used. The paraffin is heated usually by a steam coil in the bottom of the vat. This is a decided improvement over the use of the hot-water vat or the direct flame, though the hot-water bath is still used extensively.

The direct-flame method of heating has been discontinued as being too dangerous. There is naturally a tendency toward a very wide difference in the temperatures where a steam coil is used and also with the hot-water bath.

It was customary at first to have the cheese from two weeks to a month old at the time of paraffining, and the cheese that was not stored by the dealers but went directly to the retail markets was not paraffined. At the present time practically all cheese is paraffined, and as the dealers receive cheese at a much earlier period after it is made than was formerly the case, paraffining is done at a correspondingly earlier period. The work is usually done when the cheese is received at the warehouses of the dealers; economic reasons relating to handling and losses in weight have had a natural tendency toward bringing this about. Most cheese is now about one week old when it is paraffined, and practically all cheese is treated by the time it is two weeks old, though in a few cases cheese a month old is paraffined.

Most of the paraffining is done by the large dealers who buy direct from the factories, though at the present time a number of the more advanced factorymen have outfits of their own. The dealers appear to make serious objections to the factory operators doing their own paraffining, although no difference in price is made.

Slightly different grades of paraffin are used at different seasons. That commonly used in the summer months has a melting point of about 125° F., and for winter use a paraffin with a lower melting point is used. The cost is about 6 cents a pound.

CONSTRUCTION OF TANKS FOR PARAFFINING.

Tanks are made from a heavy grade of galvanized iron, supported with angle iron in the larger tanks. The tanks used by the large handlers of cheese are made wide enough to take in the largest sized cheeses edgewise; that is, about 18 inches, and deep enough totally to

submerge any cheese. They are usually deep enough to submerge the cheese after a large proportion of the paraffin has been used. Thirty inches is a good depth. The length can be made to suit the operator. They are usually about 6 feet long. A factory tank need not be so large; a good size for such would be 24 inches long, 16 inches wide, and 22 inches deep.

The tanks are heated by steam coils or in a hot-water bath, the steam being much more satisfactory, as the hot-water bath will not heat the paraffin high enough for the best work. As much heating surface as practicable should be provided because the paraffin cools very rapidly during the process of dipping. A coating of asbestos about the tank is very satisfactory to help retain the heat of the paraffin. The rack which holds the cheese should be counterbalanced by sufficient weight to hold the cheese out of the paraffin when the rack is loaded or full. Most racks are made with iron rods for the cheese to rest on. Wood in place of the iron would be more satisfactory, as the iron becomes very hot and melts the cheese where it comes in contact with it.

PREVIOUS EXPERIMENTAL WORK.

There have been a number of experiments in which the effect of paraffining on the loss in weight and the quality of the cheese were considered. It was uniformly found that the process had no detrimental effect on the quality, and that while the losses in weight of paraffined cheese during storage varied, they were under all conditions very slight, and considerably less than was the case with cheese not paraffined.

In some previous unpublished work done by the writer it was found impracticable to paraffin cheese which has been held for some time in cold storage. Such cheese when paraffined is very likely to show a heavy growth of mold under the paraffin coat, this being due to the fact that the cold surface of the cheese prevents a thorough sterilization when the paraffin is applied. This, however, has been overcome by allowing the cheese to remain in the paraffin for a longer period of time.

The numerous problems involved in the use of paraffin at different temperatures and with cheese of various ages have never been satisfactorily worked out. Many conflicting opinions have been held by different handlers of cheese as to the results to be expected from variations in age and temperature, and as previous experience with experimental cheese has seemed to indicate that many of the prevailing opinions were partly or wholly erroneous it was evident that further work was necessary to put the process on a basis of exact knowledge.

PLAN OF PRESENT WORK.

Experimental work in paraffining cheese is necessarily rather simple, as not many variations are possible in the process and the results are easily noted and comparatively conclusive. The faults common in paraffined cheese are cracking or peeling of the paraffin, undeveloped surface color, surface mold, and surface decay or rind rot. These faults, it would seem, must be due to one or more of three possible causes: (1) The age of the cheese when paraffined; (2) the temperature of the paraffin, and the length of time that it is applied; and (3) the way the cheese is handled after it has been immersed.

Handlers of cheese have contended that a high moisture content would cause serious faults, but the writer has seen considerable cheese with a high moisture content that was beyond criticism after paraffining and storing for a number of months.

In addition to determining the effect of the factors mentioned above, it seemed desirable to note the losses in weight after paraffining of cheese dipped at different ages, also the amount of paraffin which adhered to the surface of the cheese when applied at different temperatures and for varying periods of time.

The work described in the following pages was conducted at a factory near Plymouth, Wis. The factory has a very satisfactory paraffin tank heated with a steam coil, where all practical temperatures could be obtained, and its proximity to a good cold-storage warehouse in Plymouth made it especially convenient for this work.

Cheese from the regular daily make was used, vats of good curds being selected. Moisture determinations were made on each lot. The "daisy" size of cheese was used, as it is a representative type.

SHRINKAGE IN CHEESE AS AFFECTED BY THE AGE AT WHICH PARAFFINED.

As it is known that cheese of any age above one week can be profitably paraffined, the problem is reduced to a question of the earliest age when the work can be satisfactorily done. For the experiments given in this report 7 lots of cheese were made, each lot consisting of 9 cheeses. Of these, 3 were paraffined as they came from the press and before the surface moisture had had time to dry off; 3 were paraffined three days after coming from the press, and the remaining 3 seven days after coming from the press. The data of 4 of these lots, including all temperatures used, are given in the table below; the remaining lots were not weighed. The cheese was weighed immediately after paraffining and again at the time of scoring in February, after being in storage about 5 months. The cheese was stored at 35° F. The weights and losses from shrinkage were as follows:

TABLE 1.—*Shrinkage of cheese after paraffining at different periods.*

Lot No.	Cheese No.	Age when paraffined.	Weight when paraffined.	Weight when scored.	Shrinkage.
			<i>Pounds.</i>	<i>Pounds.</i>	<i>Pound.</i>
1.	1	From press.....	21.69	21.31	0.38
	2	do.....	21.84	21.34	.50
	3	do.....	21.66	21.19	.47
	4	3 days.....	21.25	21.13	.12
	5	do.....	21.41	21.31	.10
	6	do.....	21.47	21.38	.09
	7	7 days.....	21.19	21.06	.13
	8	do.....	21.00	20.88	.12
	9	do.....	21.09	20.94	.15
2.	1	From press.....	21.75	21.06	.69
	2	do.....	21.75	21.19	.56
	3	do.....	21.47	20.94	.53
	4	3 days.....	21.38	21.22	.16
	5	do.....	21.19	21.00	.19
	6	do.....	21.50	21.38	.12
	7	7 days.....	20.97	21.00	(¹)
	8	do.....	21.06	21.00	.06
	9	do.....	21.13	21.06	.07
3.	1	From press.....	21.94	21.44	.50
	2	do.....	21.56	21.16	.40
	3	do.....	21.81	21.31	.50
	4	3 days.....	21.44	21.28	.16
	5	do.....	21.38	21.28	.10
	6	do.....	21.53	21.28	.25
	7	7 days.....	20.88	20.81	.07
	8	do.....	21.00	20.94	.06
	9	do.....	21.06	20.97	.09
4.	1	From press.....	22.06	21.56	.50
	2	do.....	22.13	21.75	.38
	3	do.....	22.19	21.63	.56
	4	3 days.....	21.88	21.63	.25
	5	do.....	21.59	21.31	.28
	6	do.....	21.38	21.19	.19
	7	7 days.....	21.44	21.31	.13
	8	do.....	21.00	20.94	.06
	9	do.....	20.88	20.75	.13

¹ An apparent gain in weight, which might be due to surface moisture.*Summary of foregoing table.*

Age when paraffined.	Average weight when paraffined.	Average weight when scored.	Average shrinkage.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pound.</i>
From press:	21.81	21.31	0.50
Three days old.....	21.44	21.28	.16
Seven days old.....	21.06	20.97	.09

It is seen from the above that the average shrinkage in the cheeses paraffined from the press was 0.50 of a pound, or 8 ounces, per cheese; those paraffined when three days old shrank on an average 0.16 of a pound, or 2½ ounces; and those paraffined at seven days lost 0.09 of a pound each, or 1½ ounces.

As all the curd was weighed into the hoops to insure fairly uniform individual weights in each lot in the finished product, and the difference in the shrinkage of cheese paraffined direct from the press and that paraffined at three days of age is about the same as the difference in weight at the time of paraffining, it is fairly safe to assume that

the total press weights of all the cheese paraffined at once and of that paraffined at three days of age was approximately the same. Therefore, practically nothing was saved in the matter of shrinkage by paraffining straight from the press, as compared with paraffining at three days of age, while it is shown later on that the latter insures a better quality of product.

There are some interesting comparisons between the lots paraffined at different ages if the shrinkage before and after paraffining is considered. While there is a comparatively heavy loss in weight every day that a cheese is allowed to go unparaffined, very little seems to be gained by paraffining the cheese directly from the press, as compared with paraffining at three days of age. On the other hand, there is a very noticeable difference in the final weights and the loss sustained between cheese paraffined at three days of age and at seven days of age.

When it is considered that the shrinkage of paraffined cheese in storage apparently has very little, if any, relation to the water content of the cheese, it is difficult to explain why cheese paraffined from the press should shrink so much more in storage than cheese paraffined at three days old.

QUALITY OF THE PARAFFIN COAT AS AFFECTED BY TIME OF DIPPING AND TEMPERATURE OF PARAFFIN.

After about five months in storage the eight lots of cheese were examined and the quality of the paraffin coat graded on the basis of 100 for a perfect coating. As this was the first time scoring of this kind had been done, there was some question as to the proper allowance to make for different faults, and it is possible that in some cases where the faults were the most serious sufficient reductions were not made. However, questions of this kind always arise in connection with attempts to arrange relative quality, or lack of quality, on a numerical basis. The scoring was done by two competent judges. The detailed results, with the average scoring, are given in the following table:

TABLE 2.—*Quality of paraffin coating.*

Lot No.	Cheese No.	Temperature of paraffin.	Time dipped.	Age of cheese.	Judge.	Score.	Remarks.
		<i>° F.</i>	<i>Seconds.</i>				
1.	1	190	1	Fresh.	Mc..... M.....	85 85	Mold, heavy paraffin. Rough, some mold under bandage, bad where bandage lags.
	2	190	10	...do....	Mc..... M.....	90 88	Poor appearance. Rough, some mold, cracked in places.
	3	190	30	...do....	Mc..... M.....	91 93	Slight mold. Cracked slightly, a little mold in spots.
	4	190	1	3 days..	Mc..... M.....	94 96½	Trifle rough, some blotches, a little mold.

TABLE 2.—*Quality of paraffin coating—Continued.*

Lot No.	Cheese No.	Temperature of paraffin.	Time dipped.	Age of cheese.	Judge.	Score.	Remarks.
		^{°F.}	<i>Seconds.</i>				
1.	5	190	10	3 days..	Mc.....	95	Trifle rough.
					M.....	98	Shows little rot under paraffin.
	6	190	30	...do....	Mc.....	92	Some moisture under bandage where it laps, edge will give rind rot.
					M.....	94	Not evenly coated.
	7	190	1	7 days..	Mc.....	93	Cracked slightly, trifle rough.
					M.....	97½	Shows trifle rot under paraffin.
	8	190	10	...do....	Mc.....	92	Some moisture under bandage, will cause rind rot.
					M.....	90	
	9	190	30	...do....	Mc.....	96	
					M.....	98	Do.
2.	1	240	1	Fresh..	Mc.....	92	Moldy, poor appearance.
					M.....	95½	Trifle rough, some moldy spots.
	2	240	5	...do....	Mc.....	92	Little moldy, uneven.
					M.....	96	Little mold on paraffin, some small white dry spots.
	3	240	10	...do....	Mc.....	90	Moldy, uneven, poor appearance.
					M.....	95	Some dry blotches, trifle rough.
	4	240	1	3 days..	Mc.....	97	Good job.
					M.....	97½	
	5	240	5	...do....	Mc.....	98	Do.
					M.....	97	Trifle rough.
3.	6	240	10	...do....	Mc.....	98	Good job.
					M.....	97	Trifle rough.
	7	240	1	7 days..	Mc.....	96	Very good.
					M.....	97	Trifle rough.
	8	240	5	...do....	Mc.....	96½	Trifle uneven.
					M.....	97	Trifle rough.
	9	240	10	...do....	Mc.....	95	Trifle heavy and uneven.
					M.....	97	Trifle rough.
	1	220	1	Fresh..	Mc.....	90	Moldy and cracked appearance.
					M.....	88	
4.	2	220	5	...do....	Mc.....	90	Do.
					M.....	88	Dry blisters, moldy, paraffin cracked.
	3	220	10	...do....	Mc.....	90	Moldy and cracked appearance.
					M.....	88	
	4	220	1	3 days..	Mc.....	95	Trifle uneven and heavy.
					M.....	96½	Paraffin thick.
	5	220	5	...do....	Mc.....	95	Slight mold.
					M.....	97	Trifle rough, few small cracks.
	6	220	10	...do....	Mc.....	97	Good.
					M.....	97	Paraffin slightly cracked.
5.	7	220	1	7 days..	Mc.....	95	
					M.....	97	Trifle rough and white.
	8	220	5	...do....	Mc.....	97	Good.
					M.....	97	Trifle rough and white.
	9	220	10	...do....	Mc.....	97½	Good.
					M.....	94½	Trifle rough, some moisture under paraffin on face.
	1	275	1	Fresh..	Mc.....	90	Very moldy, poor appearance.
					M.....	92	Moldy, rough and blotches.
	2	275	5	...do....	Mc.....	90	Very moldy, poor appearance.
					M.....	92	White dry blotches, mold, and rough.
6.	3	275	10	...do....	Mc.....	90	Very moldy, poor appearance.
					M.....	92	Moldy, rough, blotches.
	4	275	1	3 days..	Mc.....	98	Good job.
					M.....	96½	Trifle rough and blotched.
	5	275	5	...do....	Mc.....	95	Slight mold.
					M.....	95½	Trifle rough.
	6	275	10	...do....	Mc.....	96½	Slight mold.
					M.....	95½	Some mold spots, trifle rough.
	7	275	1	7 days..	Mc.....	97	Good.
					M.....	96½	Trifle rough, very slightly blotched.
7.	8	275	5	...do....	Mc.....	95	Trifle heavy and uneven.
					M.....	96½	Rough.
	9	275	10	...do....	Mc.....	97	Good.
					M.....	96½	Trifle rough, very slightly blotched.
	1	190	1	Fresh..	Mc.....	91	Trifle moldy and cracked appearance.
					M.....	93½	Cracked a trifle and some mold.
	2	190	10	...do....	Mc.....	85	Mold and cracked appearance.
					M.....	90	Cracked, rough, some mold.
	3	190	30	...do....	Mc.....	89	Moldy and cracked appearance.
					M.....	94	Moldy, some blotches, cracked.
8.	4	190	1	3 days..	Mc.....	85	Mold, cracked appearance.
					M.....	85	Some mold, moist under paraffin.

TABLE 2.—*Quality of paraffin coating—Continued.*

Lot No.	Cheese No.	Temperature of paraffin.	Time dipped.	Age of cheese.	Judge.	Score.	Remarks.
		<i>°F.</i>	<i>Seconds.</i>				
5.	5	190	10	3 days..	Mo.....	82	Uneven and heavy coated.
					M.....	80	Much moisture under paraffin.
	6	190	30	...do....	Mo.....	86	Uneven and heavy coated.
					M.....	89	A trifle better than lot No. 5, cheese No. 5, but same trouble.
	7	190	1	7 days..	Mo.....	87	Heavy coated and uneven.
					M.....	90	Some moisture under paraffin, rough.
	8	190	10	...do....	Mo.....	86	Heavy coated, dull appearance.
					M.....	85	Moist under paraffin.
	9	190	30	...do....	Mo.....	85	Uneven, shows rind rot.
					M.....	88	Rough, moist under paraffin, coarse rot all over surface.
	1	240	1	Fresh..	Mo.....	90	Moldy, cracked, poor appearance.
					M.....	87	Rough, moist under paraffin on face.
6.	2	240	5	...do....	Mo.....	90	Moldy, cracked, poor appearance.
					M.....	87	Same as lot No. 6, cheese No. 1.
	3	240	10	...do....	Mo.....	90	Do.
					M.....	87	Badly cracked and moldy.
	4	240	1	3 days..	Mo.....	95	Uneven, slight rot on end.
					M.....	94½	Rough, some moisture under paraffin on face.
	5	240	5	...do....	Mo.....	97½	Good.
					M.....	96	Few blotches, trifle rough.
	6	240	10	...do....	Mo.....	90	Uneven, heavy, slight rind rot.
					M.....	94	Some moisture under paraffin; will rind rot.
	7	240	1	7 days..	Mo.....	95	Uneven, slight rot on one end.
					M.....	93	Rough, moist on face under paraffin.
7.	8	240	5	...do....	Mo.....	95	Same as lot No. 6, cheese No. 1.
					M.....	94½	Rough, moist under paraffin.
	9	240	10	...do....	Mo.....	95	Uneven, slight rot on one end.
					M.....	94½	Rough, moist under paraffin on one face.
	1	220	1	Fresh..	Mo.....	94	Slight mold.
					M.....	94	Cracked paraffin, moldy.
	2	220	5	...do....	Mo.....	95	Uneven and heavy.
					M.....	97	Some dry blotches.
	3	220	10	...do....	Mo.....	93	Slight mold.
					M.....	92	Paraffin cracked and moldy.
	4	220	1	3 days..	Mo.....	98	
					M.....	97½	Not moldy.
8.	5	220	5	...do....	Mo.....	98	Slight mold.
					M.....	97½	
	6	220	10	...do....	Mo.....	94	Do.
					M.....	94	Moldy and blotched.
	7	220	1	7 days..	Mo.....	94	Uneven and heavy.
					M.....	95½	Some moisture under paraffin.
	8	220	5	...do....	Mo.....	97½	
					M.....	97	Trifle uneven, no mold.
	9	220	10	...do....	Mo.....	97½	
					M.....	97	Trifle white.
	1	240	1	3 days..	Mo.....	97	Good.
					M.....	97	Trifle rough.
8.	2	240	1	...do....	Mo.....	95	Slight mold, trifle uneven.
					M.....	96½	Trifle rough.
	3	240	1	...do....	Mo.....	95	Slight mold, trifle uneven.
					M.....	94½	Moldy, dry blisters.

Average scores:

From press.....	90.7
Three days of age.....	94.3
Seven days of age.....	94.6

RESULTS OF PARAFFINING FROM THE PRESS.

At the time of scoring it was noticed that practically every cheese paraffined at the time it came from the press was covered with blue mold, which was growing on the surface of the paraffin and not between the paraffin coat and the surface of the cheese. In some cases there was not sufficient mold to materially affect the sale value

or to make it necessary to clean the surface, but the greater number of the cheeses were badly covered. The writer has no definite reason to offer as to why mold should grow on the surface of a cheese paraffined when taken from the press when it does not grow on a cheese paraffined at 3 days of age or older. It is possible, however, that some whey found its way through the paraffin covering and furnished conditions of food and moisture necessary for the growth of the mold. Appreciable quantities of moisture escaped from the paraffined cheese, as has been noted in the discussion following Table 1.

Cheese paraffined from the press does not get the color of the rind as quickly as when the color is allowed to develop before paraffining. It requires about a month for the color to fully develop, and if the dipping is done in the factory the dealer is likely to be suspicious that the cheese has too much acid. The slowness with which the color develops in the cheese paraffined fresh from the press would be a serious disadvantage if the cheese were intended to go on the market at once, but it would be no disadvantage where the cheese is to remain in storage for some time. However, the growth of mold on the surface of cheese treated at this stage is of itself sufficient to condemn the practice of paraffining from the press.

RESULTS OF PARAFFINING AT THREE DAYS.

The results for the cheese paraffined at three days from the press are summarized in the following table:

TABLE 3.—Average scores of cheese paraffined three days from press.

Temper- ature of paraffin.	Scored by Mc.				Scored by M.			
	Time dipped (seconds).				Time dipped (seconds).			
	1	5	10	30	1	5	10	30
°F.								
190.....	90	.....	88½	89	90½	.....	89	91½
220.....	96½	95	95½	.....	97	97	95½	.....
240.....	96	97½	94	.....	96	96½	95½	.....
275.....	98	95	96½	.....	96½	95½	.....	.....

The table shows uniformly good results at 220° F. and higher temperatures. At 190° F. the results were usually unsatisfactory. It was observed at the time of paraffining that with cheese immersed in paraffin at 190° F. for one second the paraffin did not adhere to the surface and could be peeled off. Therefore when such cheese was roughly handled the paraffin would be likely to crack and scale off. A cheese dropped on the floor to test this point showed bad cracks,

due to the heavy coating of paraffin and to the fact that it had not cemented to the surface of the cheese. When the cheese was dipped for 10 seconds, the surface of the cheese became sufficiently heated to allow the paraffin to penetrate it while the excess paraffin dripped off before solidifying.

RESULTS OF PARAFFINING AT SEVEN DAYS.

The judges gave the cheese paraffined at seven days practically the same average score as the cheese paraffined at three days of age. In this connection, however, attention should be called to a defect or fault in the paraffining which was noted very much oftener in the cheese paraffined at seven days than in the cheese paraffined at three days. This particular fault goes by the term "rind rot" and is characterized as moisture under the paraffin. It is a genuine decay of the surface of the cheese and shows white blotches of varying size, sometimes small and sometimes covering a large part of the cheese. These whitened areas do not, as a rule, detract materially from the appearance of the cheese as does mold or cracks in the paraffin, but the rind rot does injure the cheese itself, which is not the case with mold or cracked paraffin. Because of this tendency to rind rot in the cheese paraffined at seven days of age paraffining at three days of age is much preferable. The writer has observed some cheese paraffined at a greater age than seven days and the tendency to rind rot was more pronounced than in the cheese paraffined at an earlier stage.

In this connection it seems worthy of note that buyers and handlers of cheese in general have maintained that rind rot was due to the cheese having too much moisture or to paraffining the cheese before the surface had dried after removing from the press. The results would indicate that rind rot is due to an entirely different condition, not related directly at least to the moisture of the cheese. A little misunderstanding might result from the fact that the terms "surface moisture" and "rind rot" are used interchangeably in Table 2. This use of the term "surface moisture" is a mistake, and the term is commonly used because of an apparent rather than a real condition.

INFLUENCE OF LENGTH OF IMMERSION.

There was no appreciable advantage in the use of any particular length of time for the immersion except as noted above for the lower temperature. At 220° F. and upward good results were secured at 1, 5, and 10 seconds.

EFFECT OF KEEPING CHEESE IN WARM ROOM AFTER PARAFFINING.

Many factory men paraffin cheese to prevent shrinkage and then allow the cheese to stand in the factory curing room several days before placing it in cold storage. Lot 8 in Table 2 was included in the experiments to determine the effect of this practice on the appearance of the cheese. In this lot were three cheeses paraffined at three days from the press; No. 1 went to storage at once, No. 2 after three days, and No. 3 after one week. The curing room was warm, and the cheese commenced to look white three days after paraffining; the one that remained in the curing room one week was markedly so. This white appearance was also noticeable at the time of scoring, but as it was evenly distributed and not in blotches the judges did not see fit to make a deduction for this defect. It is probable, however, that most of the objections on the part of the dealers to paraffining in factories is due to this change in color caused by holding the cheese too long after paraffining before shipping to storage.

AMOUNT OF PARAFFIN USED AT DIFFERENT TEMPERATURES.

To determine the amount of paraffin retained by the cheese when immersed at different temperatures for different periods of time, tests were made at 190°, 249°, and 275° F. At the lower temperature, periods of 1, 5, and 30 seconds were used; at 240° and 275° F., periods of 1 and 10 seconds. Eight cheeses of the "daisy" style were used in each test. The results are given in the table below:

TABLE 4.—*Amount of paraffin retained by cheese after immersion.*

Temperature of paraffin.	Time dipped.	Weight of each lot of cheese—		Paraffin retained by cheese.
		Before dipping.	After dipping.	
° F.	Seconds.	Pounds.	Pounds.	Pounds.
190	1	168.81	169.94	1.13
	5	168.94	170.00	1.06
	30	168.50	169.33	.83
240	1	169.25	170.16	.91
	10	167.91	168.56	.65
275	1	168.06	168.78	.72
	10	168.72	169.22	.50

The table shows that there is considerable variation in the amount of paraffin adhering to the surface of the cheese when dipped at different temperatures and for different periods. However, the total amount retained by any one lot is very small compared with the weight of the cheese paraffined; and when it is considered that the total surface of the cheese in each lot was about 25 square feet, it can be seen that the paraffin coat is very thin. Though paraffin costs

much less per pound than cheese, it is only in exceptional cases that any attempt is made to give the cheese a heavier coat than is necessary to protect it.

SUMMARY.

1. Paraffining is an effective method (1) of preventing losses in weight of cheese due to evaporation, and (2) of preventing the growth of mold.

2. All temperatures of the melted paraffin of 220° F. and above are satisfactory for doing this work, and the experiments showed that the length of time (from 1 to 10 seconds) the cheese was immersed at these temperatures was immaterial.

3. A temperature of 190° F. secured in a hot-water-bath outfit was not satisfactory, but where it is used the cheese should be immersed for at least 5 seconds.

4. Paraffining at three days from the press gave the best results.

5. The amount of paraffin adhering to the cheese varied with different temperatures of the paraffin and the length of time the cheese was immersed.

6. Cheese should not be allowed to remain in a warm curing room for more than one day after paraffining.



636. 073

U 58

B95C

GENERAL LIBRARY,
UNIV. OF MICH.
DEC 14 1911

Issued November 9, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 182.

A. D. MELVIN, CHIEF OF BUREAU.

THE SPONTANEOUS OXIDATION OF ARSENICAL DIPPING
FLUIDS.By AUBREY V. FULLER,
Assistant Chemist, Biochemic Division.

INTRODUCTION.

During the past year and more there has devolved upon the Biochemic Division of this bureau the work of executing numerous analyses of samples of arsenical dipping fluids used by the Zoological Division for experimental purposes in connection with the eradication of cattle ticks.¹

The baths in question were prepared in a manner similar to that described in Bureau of Animal Industry Order 178, page 9, issued March 17, 1911, the essentials of the method being to mix pure arsenic trioxid with an excess of sal soda, and to boil this mixture with water for 15 minutes "or longer if necessary to effect complete solution of the arsenic." The solution is then cooled, pine tar added, and the volume brought to 500 gallons by the addition of clear water. The bath thus prepared should contain in solution sodium arsenite equivalent to approximately 0.24 per cent of arsenic trioxid.

The observation having been made that in several instances batches of used dip which had been allowed to stand in the vats for varying periods of time showed an apparent loss of arsenic, a special study was undertaken to determine if possible the conditions under which this loss took place.

METHODS OF ANALYSIS.

METHOD A.—ARSENIOUS OXID PRESENT AS SUCH.

Fifty cubic centimeters of the dip was pipetted into a separatory funnel of 300 c. c. capacity, acidified with dilute sulphuric acid, and the tar removed by extraction with ether. Comey² states that ether

¹ The results of these experiments are reported in a paper by Ransom and Graybill in the Twenty-seventh Annual Report of the Bureau of Animal Industry (now in press). The details of the experiments are given more fully in another paper by the same authors which is to be issued as Bulletin 144 of the Bureau of Animal Industry.

² A Dictionary of Chemical Solubilities, 1896, p. 30.

10100*—Cir. 182—11

extracts almost no arsenic trioxid from a saturated solution containing free sulphuric acid. The aqueous layer was run into a second funnel and extracted with a fresh portion of ether, the ether remaining from the first extraction being washed three times with 25 c. c. portions of 2 per cent sulphuric acid. The ether extraction was repeated until the upper layer in the last funnel appeared colorless on separating, showing complete removal of the tarry matter. Three extractions have been found sufficient in most cases.

The acid washings were put through the ether residues in proper sequence, and finally the aqueous solutions were combined in an Erlenmeyer flask and the dissolved ether was expelled by heating on the steam bath. This latter step may not be necessary, but seems indicated in view of the fact that water containing sodium bicarbonate and saturated with ether yields a precipitate with iodine solution. The liquid was then cooled, made alkaline with sodium bicarbonate, and titrated with tenth-normal iodine, using starch paste as the indicator. One cubic centimeter of tenth-normal iodine equals 0.00495 gram arsenic trioxid.

METHOD B.—TOTAL ARSENIC.

Fifty cubic centimeters of the dip was introduced by means of a pipette into a 100 c. c. measuring flask, acidified with dilute hydrochloric acid, using a drop of methyl orange to read the change, then made to volume with water and thoroughly mixed. The solution was then passed through a quantitative filter and after rejecting the first portions of the filtrate 20 c. c. aliquots of the filtrate were taken for analysis.

From this point the method of Andrews and Farr¹ was employed. This method is based upon the well-known fact that arsenic is reduced to the metallic state by stannous chlorid in strong hydrochloric acid solution. These authors use a reagent consisting of concentrated hydrochloric acid containing 20 grams of stannous chlorid crystals and 40 grams of tartaric acid to the liter, the latter being added to prevent the co-precipitation of tin.

This reagent is mixed with the solution under examination in large excess, and kept at a temperature of 35° to 40° C. for three hours, in a flask provided with a tightly fitting glass stopper. The liquid is then filtered off through a Gooch crucible, the precipitated arsenic after washing with hydrochloric acid and water is returned together with the asbestos mat to the original flask, and the metal is dissolved in an excess of standard iodine solution in the presence of sodium bicarbonate or phosphate. Finally the excess of iodine is determined by titration with either arsenious acid or sodium thio-

¹ American Journal of Science, vol. 27, No. 160, p. 316, 1909.

sulphate. From the amount of iodine consumed the weight of arsenic trioxid is calculated, the reaction taking place in accordance with the following equation:



The method was found to yield good results when the directions of the authors were closely followed, particular attention being paid to the concentration of hydrogen chlorid in the reacting mixture.

APPARENT LOSS OF ARSENIC IN SAMPLES FROM THE FIELD.

The accompanying table embodies the data obtained in connection with the examination of samples of dips exhibiting the peculiar change.

Results of examination of samples of dip.

SERIAL NO. 777.

Date.	Per cent actual As_2O_3 .	Remarks.
Not recorded	0.040	Stood in vat. No analysis of original sample, but made to contain 0.24 per cent As_2O_3 .

SERIAL NO. 778.

October, 1909.....	0.225	Original sample.
December, 1909.....	.020	Stood in bottle in laboratory.

SERIAL NO. 887.

June, 1910.....	0.231	Stood in vat about 1 month before sample was taken.
October, 1910.....	.011	Stood in bottle in laboratory.

SERIAL NO. 971.

June 23, 1910.....	0.217	Original sample.
July 14, 1910.....	.218	Stood in vat.
September 15, 1910.....	.040	Do.
October 20, 1910.....	.020	Do.

In the examination of these samples method A was employed, which it will be seen is designed primarily for the determination of arsenic present in the trivalent state and hence when applied to the determination of total arsenic must rest upon the assumption that the metal is present entirely in this condition. That this assumption was warranted seemed indicated in view of the fact that it is generally considered that arsenic trioxid is not prone to rapid oxidation when subjected to moderate boiling with alkali carbonates, though this tendency is quite marked when the hydroxids are used.

However, it was deemed advisable to verify this hypothesis experimentally. With this object in view, determinations of arsenious

arsenic and total arsenic were made on several samples of freshly prepared dips and concordant results were obtained, thus establishing the validity of the assumption.

As an additional check, the total arsenic was determined in serial No. 971, which is selected as a typical illustration of the progressive loss of arsenious arsenic, with the following results:

Original concentration of arsenious arsenic, June 23, 1910, 0.217 per cent As_2O_3 .

Concentration of arsenious arsenic, July 14, 1910, 0.218 per cent As_2O_3 .

Concentration of arsenious arsenic, September 15, 1910, 0.040 per cent As_2O_3 .

Concentration of arsenious arsenic, October 20, 1910, 0.020 per cent As_2O_3 .

Concentration of total arsenic, October 20, 1910, 0.217 per cent As_2O_3 .

Since the figure for total arsenic in solution was in exact agreement with the original value, it is evident that none had been actually removed from the bath.

EXPERIMENTAL WORK.

Several hypotheses suggested themselves to the writer as possibly serving to explain the alteration observed in the samples in question. These hypotheses, together with the experimental work done in testing their adequacy, will now be discussed.

ORGANIC COMBINATION OF THE ARSENIC.

One explanation which was considered was that the arsenic had in some obscure manner formed an organic compound with certain constituents of the pine tar present, and that this compound was soluble in ether and was thus lost when the first method of analysis was employed. Though this possibility was considered quite remote, it was decided to subject it to experimental examination. To this end a 20 c. c. portion of a sample which had exhibited the change was shaken out with ether in the manner described and a determination made of the total arsenic in the aqueous layer. The result was in agreement with that obtained by the total arsenic method previously described, thus removing the possibility of explaining the phenomenon on these grounds.

OXIDATION BY AIR IN THE PRESENCE OF PINE TAR.

It having been shown by the previous experiment that the arsenic was not lost through organic combination, the only remaining alternative was that it had undergone oxidation. That such was the case was shown in the following manner:

A sample of serial No. 971¹ was extracted with ether as previously described and the arsenic precipitated with magnesia mixture. The voluminous precipitate of magnesium ammonium arsenate with

¹ Compare results on pp. 3 and 4. This analysis was made subsequent to October 20, 1910.

presumably some phosphate was filtered off, washed, dissolved in hydrochloric acid, and after the addition of potassium iodid¹ the arsenic was precipitated as the trisulphid by means of hydrogen sulphid.

The sulphid was collected on a filter, washed with water containing hydrochloric acid and hydrogen sulphid, and then dissolved by heating with sodium hydroxid solution with the addition of 50 c. c. of hydrogen peroxid. By this treatment the sodium sulpharsenite is oxidized to arsenate and sulphate and the solution may be acidified without reprecipitation of arsenic sulphid.

The solution was next made slightly acid with sulphuric acid, filtered, the filtrate made slightly alkaline with ammonia, and the arsenic again precipitated as magnesium ammonium arsenate. This precipitate was finally ignited and weighed as magnesium pyroarsenate in the usual manner.

The result closely approximated that obtained for total arsenic by the Andrews and Farr method, and served to prove beyond a doubt that the process operative in this instance was one of oxidation.

Although, as previously mentioned, sodium arsenite in the presence of carbonate does not suffer marked oxidation, it was considered entirely possible that such might be accomplished through the agency of the pine tar contained in these samples. Commercial pine tar contains terpenes and other bodies found in oil of turpentine, among which are certain compounds which form oxidation products on exposure to the air. These products readily yield their oxygen to reducing substances, such as sodium sulphite, and to certain organic substances, such as guaiac, in the presence of various enzymes, this property constituting the basis of several chemical tests for establishing the presence of certain of such latter bodies. Hence it was regarded as quite possible that the peroxids or similar bodies formed by the action of air on the pine tar might in turn effect the conversion of the sodium arsenite to arsenate.

To test this suspicion a sufficient quantity of the "dip" was prepared according to directions previously referred to, and the arsenic determined according to method A. The solution was then placed in a tall cylinder and a moderate current of air passed through it for a period of eight days. At the end of this time a second sample was taken and analyzed for arsenite with the result that the value obtained was identical with the first, no oxidation having taken place. The experiment was repeated, using a different sample of pine tar, with the same result.

Evidently, then, the cause of the phenomenon lay elsewhere.

¹ The potassium iodid feature was proposed by De Koninck (*Bulletin de la Société Chimique de Belgique*, vol. 23, p. 88, 1909) for the purpose of hastening the reduction and consequently the precipitation of pentavalent arsenic.

BACTERIAL ACTION.

All attempts to explain the oxidation of the arsenite on a purely chemical basis having proved unfruitful, the action of micro-organisms was next considered.

While numerous species of fungi have been found to possess the property of reducing¹ arsenic compounds to arsin, the author has been unable to find in the literature any mention of the reverse property of effecting oxidation of arsenites.

Although compounds of arsenic have long been used as insecticides and exert marked toxic effects on the higher organisms, the arsenites and arsenates possess but little antiseptic or disinfecting power against the lower fungi, except when present in rather high concentration. Thus, according to Rideal,² Miquel found that there was required 6 grams of arsenic trioxid to the liter to prevent bacterial growth in beef tea, and that 125 grams of potassium arsenate or 9 grams of sodium arsenate were required to accomplish the same purpose. It was therefore not surprising that a sample of an arsenical dip which exhibited the characteristic oxidation contained numerous living bacteria, as was demonstrated by making plate cultures on nutrient agar inoculated with the dip.

Acting upon this clue, the following experiment was carried out to determine if the bacteria present in a sample of used dip could bring about oxidation in a fresh sample and also to determine the conditions under which this oxidation might take place.

A batch of arsenic pine-tar dip was prepared after the manner previously described, 800 c. c. portions were placed in each of 10 flasks having a capacity of 1,500 c. c., and were further treated as shown in detail in the ensuing table. The flasks having been prepared, samples were taken for analysis by withdrawing the cotton stoppers with which they were provided, thoroughly flaming the necks, and pouring about 60 c. c. from each into a 100 c. c. graduated cylinder, from which containers the desired portions were removed by means of a transfer pipette. The flasks were then placed in a dark closet and allowed to remain at room temperature with occasional agitation for one month. At the expiration of this time samples were taken as before and analyzed for arsenious arsenic. In the accompanying table are given the descriptions of the contents of the various flasks, together with the initial and final percentages of actual arsenic trioxid as determined by method A.

¹ Compare W. Kruse, *Allgemeine Mikrobiologie*, Leipzig, 1900.

² *Disinfection and Preservation of Food*, New York, 1903, pp. 176-177.

Results of examination of samples of dip to determine oxidation of arsenic.

Flask No.	Description.	Initial per cent As_2O_3 .	Final per cent As_2O_3 .
1	Straight dip sterilized ¹	0.286	0.222
2	Straight dip sterilized + 20 c. c. used bath No. 971.....	.225	.197
3	Straight dip + 66 c. c. broth sterilized.....	.221	.207
4	Straight dip + 66 c. c. broth + 20 c. c. used bath No. 971.....	.217	.006
5	Straight dip sterilized + 50 c. c. raw cattle urine.....	.215	.190
6	Straight dip sterilized + 50 c. c. sterilized ² cattle urine.....	.223	.198
7	Straight dip + 50 c. c. sterilized cattle urine + 20 c. c. used bath No. 971.....	.223	.179
8	Straight dip + 60 c. c. broth sterilized + 50 c. c. sterilized cattle urine.....	.214	.188
9	Straight dip + 66 c. c. broth sterilized + 50 c. c. sterilized cattle urine + 20 c. c. used bath No. 971.....	.209	.011
10	Straight dip sterilized + 50 c. c. raw cattle urine + 20 c. c. used bath No. 971 ..	.242	.011

¹ Sterilization was accomplished by heating in the autoclave at 12 pounds pressure for 50 minutes.

² Sterilized in the same manner as the arsenic solutions.

Comparison of the above initial and final values for trivalent arsenic develops the fact that although none of the flasks showed absolute freedom from oxidation, the change was most striking in Nos. 4, 9, and 10. These flasks contained in addition to the arsenite-tar solution a suitable culture medium, and each was inoculated with a portion of a dip which had been used in the field and in which oxidation had taken place. In other words, the inoculum contained an organism which when transplanted to a solution containing sodium arsenite and pine tar of the concentration indicated, and in addition a suitable culture medium, was capable of producing almost complete oxidation of the arsenite. That only a slight oxidation was obtained in flask No. 7 may be explained by the fact that the urine through sterilization had been rendered unsuitable as a culture medium, it being the usual practice when this fluid is used for the cultivation of bacteria to accomplish sterilization by passing it through a Chamberland filter.

Since the pine tar was an undesirable constituent of the solutions used for experimental purposes in that it rendered them opaque, thus making impossible observation of clouding due to bacterial growth, it was determined to eliminate it if proof could be obtained that its presence was not essential for the occurrence of the phenomenon of oxidation. To this end a solution of sodium arsenite (0.220 per cent As_2O_3) containing 20 per cent of neutral bouillon¹ was prepared and placed in a liter flask provided with a two-holed rubber stopper and glass tubes. The exterior ends of the tubes were plugged with cotton, and the flask thus fitted was sterilized in the autoclave. After cooling, the flask was inoculated with 20 c. c. of sample No. 971, and connected in series with a wash bottle containing sterile water and one containing concentrated sulphuric acid to which was added potassium bichromate. A slow current of air was

¹ The As_2O_3 and Na_2CO_3 were dissolved by boiling in 50 c. c. water, this solution was added to the bouillon, and the mixture was boiled and filtered in order to remove phosphates, etc., which would otherwise precipitate during the process of sterilization. The filtrate was then made to the required volume with distilled water and the arsenic content established by titration with iodine solution as described.

passed first through the bottle containing the acid to render it sterile, then through the water to saturate it with moisture, and finally through the culture flask.

At the end of 10 days the arsenic had been practically completely oxidized, thus establishing the fact that the pine tar played no essential part in the reaction.

Further experiments have shown that it is possible to bring about oxidation by inoculating a flask with so small a quantity as five loopfuls of a solution which has shown the oxidation, and to carry this inoculation with its attendant oxidation progressively from one flask to another.

Attempts have been made to isolate, by the ordinary bacteriological methods, the organism or organisms causing the oxidation, but so far they have proved unfruitful. This work will be continued as the opportunity presents itself.

SUMMARY AND CONCLUSIONS.

1. It has been shown in the present paper that sodium arsenite may undergo oxidation to arsenate through the agency of a microorganism or organisms not yet identified.

2. This oxidation may be quite rapid and in time proceeds practically to completion. The velocity of the reaction is dependent, of course, upon the number of the organisms introduced and upon their rate of multiplication, the latter factor being determined by the nature and quantity of organic matter present, the temperature, and, in short, all the agencies which influence bacterial growth.

3. Inasmuch as the organism or organisms in question have not as yet been identified, it is impossible to state at present just how they gain access to the baths. There are several channels through which the inoculation might be effected, namely, through the water used in preparing the solutions, through the air, or through excrementitious or other matter derived from the cattle which pass through the dip.

4. In view of the fact that the conditions to which the baths are exposed in actual practice are necessarily subject to wide variations, it is difficult to set a limit to the time which a given dip might be allowed to remain idle without undergoing alteration. However, it would appear safer to discard any batch of dip which is more than a few weeks old unless there is positive evidence that it retains its original concentration of actual sodium arsenite.

5. Efforts will be made to isolate the causative agent of this phenomenon and to study its properties.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *September 9, 1911.*



636.073

U58

B95c

Issued December 11, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 183.

A. D. MELVIN, CHIEF OF BUREAU.

GENERAL LIBRARY
UNIV. OF MICH.

JAN 27 1912

DIRECTIONS FOR CONSTRUCTING A VAT AND DIPPING CATTLE TO DESTROY TICKS.

BY

H. W. GRAYBILL, D. V. M.,
Assistant Zoologist, Zoological Division,

AND

W. P. ELLENBERGER, D. V. S.,
Veterinary Inspector, Inspection Division.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY,
and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: E. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 18, 1911.

SIR: I have the honor to transmit the accompanying paper entitled "Directions for Constructing a Vat and Dipping Cattle to Destroy Ticks," by Drs. H. W. Graybill and W. P. Ellenberger, of this bureau. This circular not only gives directions for preparing arsenical dips and for dipping cattle, but contains plans and specifications for the construction of a suitable dipping vat. It has been prepared to meet the need for such information in connection with the work being done by the bureau in cooperation with State and local authorities for the eradication of the ticks which spread the contagion of Texas or southern cattle fever. I respectfully recommend that it be published in the circular series of this bureau.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

14556°—Cir. 183.

3

CONTENTS.

	Page.
Arsenical dips.....	5
Preparation and use of arsenical dips.....	5
Precautions in the use of arsenic.....	8
Method of dipping.....	9
Specifications for the construction of a concrete cattle-dipping vat.....	10
Site.....	10
Excavation.....	10
Forms.....	12
Concrete.....	12
Waterproofing.....	13
Exit incline.....	13
Slide.....	13
Cover.....	14
Dripping pen.....	14
Chute.....	14
Bill of materials for vat, dripping pen, and chute.....	14

ILLUSTRATION.

FIG. 1. Plans for a concrete dipping vat.....	11
---	----

DIRECTIONS FOR CONSTRUCTING A VAT AND DIPPING CATTLE TO DESTROY TICKS.

In the course of the work of tick eradication, which the Bureau of Animal Industry has undertaken in cooperation with the States of the quarantined area, there has arisen a demand for a brief publication treating of the preparation and use of arsenical dips and giving plans and specifications for a dipping vat suited to the conditions and requirements on the ordinary farm.¹ It is with the view of supplying this information that the present circular has been prepared. Those who may desire information on the life history of the tick or further information relating to methods of its eradication are referred to more extensive publications on those subjects.²

ARSENICAL DIPS.

Arsenical dips as agents for destroying cattle ticks have come into much favor during the past few years. This has been due to their efficacy, cheapness, the ease with which they are prepared, and the comparatively slight injury they cause to cattle when properly prepared and used. Homemade dips are the ones most commonly used and are quite satisfactory in every way when ordinary care is used in their preparation. Recently there has been placed on the market a proprietary concentrated arsenical dip which has given good results. This dip is prepared for use by diluting it with cold water in the proportions of 1 to 100. The only advantage in such a dip is that comparatively little time is required in preparing the bath, but this advantage is largely counterbalanced by the fact that it is more expensive than a homemade dip.

PREPARATION AND USE OF ARSENICAL DIPS.

The formula most commonly used in making an arsenical dip is the following:

Sodium carbonate (sal soda).....	pounds..	24
Arsenic trioxid (white arsenic).....	do.....	8
Pine tar.....	gallon..	1
Water sufficient to make 500 gallons.		

¹ In preparing the plans of the vat shown in this circular consideration has been given to the question of cost as well as to practicability of design. The plans for a vat that has been used extensively and with much success by bureau inspectors in the tick eradication work in Alabama have been followed in part.

² Farmers' Bulletin 378, Bureau of Animal Industry Bulletin 130, and Bureau of Entomology Bulletin 72, all issued by the United States Department of Agriculture.

If for any reason a stronger dip is desired, 25 pounds of sodium carbonate and 10 pounds of arsenic trioxid may be used in place of the amounts given in the above formula. The stronger dip is required by the regulations of the Bureau of Animal Industry in the dipping of cattle which are to enter interstate commerce from quarantined areas, but for ordinary eradication work when immediate removal of the cattle to tick-free areas is not contemplated it will probably be best to use the weaker solution, and this is especially true during hot weather and when the animals are to be treated every two weeks.

In preparing the dip a large caldron or galvanized tank is required for heating the water in which to dissolve the chemicals. Thirty or forty gallons of water should be placed in the caldron or tank and brought to a boil. The amount of sodium carbonate indicated in the formula is then added and dissolved by stirring. When this is accomplished, the required amount of arsenic is added and dissolved in a similar manner. The fire is then drawn, and the solution permitted to cool to 140° F., or this process may be hastened by the addition of cold water. The pine tar is then added slowly in a thin stream and thoroughly mixed with the solution by constant stirring. This solution is diluted to 500 gallons before using.

If a larger caldron or tank is available for preparing the dip, a greater quantity of solution may be prepared at one time, always, of course, in the same proportion as the above. In this way the time required in preparing the amount of solution necessary to fill a vat is reduced considerably. In case it is necessary to use a smaller container, say of about the capacity of 25 gallons, only half the amount of solution indicated should be prepared at one time, the quantities of ingredients used being half those in the formula. This will, however, require so much time in preparing the amount of solution necessary to fill a vat that when possible it is advisable to provide a larger vessel for dissolving the chemicals.

The caldron or tank and utensils used in preparing the dip should be kept free from grease or oil, as small quantities of these may envelop particles of arsenic and prevent or hinder the solution of the arsenic. It should also be borne in mind that when hard water is used in the preparation of the dip the dissolving of the sodium carbonate (sal soda) in the boiling water results in the formation of a fine white or gray insoluble powder or precipitate of lime salts which may be taken for undissolved arsenic, and thus lead to the belief that all of the arsenic has not gone into solution.

The arsenical solution may be poured into the vat as rapidly as it is prepared until the amount required to fill the vat, when properly diluted, has been made. The most convenient way of diluting the solution is to run the water into the vat through a hose or pipe.

The capacity of the vat at the depth to which it is necessary to fill it for dipping, if not known, should be calculated, and for future convenience the water line should be plainly marked at some point on the wall of the vat. After the exact amount of solution necessary to furnish diluted dip to fill the vat has been prepared and placed in the vat all that is necessary is to allow water to flow into the vat until the surface of the dip reaches the mark made on the side of the vat. For example, if the capacity of the vat is 2,000 gallons, then four times the amount of solution necessary to make 500 gallons of dip should be prepared, placed in the vat, and the latter filled with water to the 2,000-gallon mark. In case the vat leaks it will be necessary to modify the above procedure by placing the concentrated arsenical solution necessary to fill the vat in barrels and only placing it in the vat when the latter is nearly filled with water, being careful to note, however, that there is ample capacity remaining so that when the solution in the barrel is added the dip surface will not be above the mark to which the vat is to be filled.

The capacity of the vat planned in this circular at a depth of 5 feet 3 inches is 1,470 gallons. In order to fill it to that depth with dip it will be necessary to prepare two batches of concentrated dip each containing the ingredients necessary for making 500 gallons of diluted dip and a third batch containing 7 pounds 9 ounces of arsenic and 22 pounds 3 ounces of sodium carbonate in case 8 pounds of arsenic are being used to the 500 gallons, or 9 pounds 7 ounces of arsenic and 22 pounds 8 ounces of sodium carbonate in case 10 pounds of arsenic are being used to the 500 gallons.

When for any reason it is not convenient to follow the above method of diluting the dip, a stock solution may be prepared in which the quantity of ingredients for 500 gallons of diluted dip are dissolved in 50 gallons of water. Nine parts of water to 1 part of this stock solution will then give the proper dilution. The stock solution is found very convenient for replenishing the dip in a vat when it has become too low for dipping. A stock solution should not be made in more concentrated form than that given (50 gallons of stock for 500 gallons of dip), as the pine tar does not remain properly mixed when the solution is too concentrated.

The arsenical dip may be left in the vat and used repeatedly, replenishing it with the proper quantities of water and stock solution when necessary. When, however, the dip becomes filthy through the addition of manure and dirt carried in by the cattle, the vat should be emptied, cleaned, and filled with fresh fluid. The frequency with which this should be done must be left to the owner, as the condition of the dip at any period after it has been made depends on a variety of conditions, such as the number of cattle dipped, the frequency of the dippings, etc. Even though the dip may not become very filthy,

its efficacy decreases somewhat on standing, owing to gradual oxidation of the arsenic. It is therefore advisable to recharge the vat if the dip is more than a month or six weeks old irrespective of its condition as to cleanliness.

At the conclusion of each dipping it is well to mark the position of the surface of the dip on the side of the vat in order to determine at the next dipping whether there has been a change in the level of the dip. If the surface of the dip has fallen and it is known that the vat does not leak, there has been a loss of water by evaporation and consequently an increase in the strength of the dip. In order to bring the dip down to its former strength water should be run into the vat until the dip surface reaches the mark made at the last dipping. If the fall has been due to the vat leaking, the strength of the dip has not been altered and consequently water alone should not be added. If the dip surface has been raised by rain the amount of water added in this way should be determined by calculation, and for every nine gallons of water one gallon of the stock solution previously mentioned should be used.

When not in use the vat should be tightly covered with a waterproof cover to prevent evaporation on the one hand and further dilution by rain on the other hand. Securely covering the vat when not in use also lessens the risk of accidental poisoning of stock and human beings.

PRECAUTIONS IN THE USE OF ARSENIC.

On account of the fact that arsenic is a dangerous poison, great care must be observed in making and using the arsenical dip. From the time the arsenic is procured from the druggist until the last particle of unused residue is properly disposed of, the most scrupulous care should be taken in handling it. Guessing at weights or measures or carelessness in any particular is liable to result in great damage, and not only may valuable live stock be destroyed, but human beings may lose their lives as well.

Persons using the dip should bear in mind the possibility of absorbing arsenic through cuts, scratches, or abrasions of the skin and also by inhalation of vapors from the boiler in which the dip is prepared. It should be remembered that the absorption of even very small quantities of arsenic, if repeated from day to day, is liable ultimately to result in arsenical poisoning.

Cattle should always be watered a short time before they are dipped. After they emerge from the vat they should be kept on a draining floor until the dip ceases to run from their bodies; then they should be placed in a yard free of vegetation until they are entirely dry. If cattle are allowed to drain in places where pools of dip collect, from which they may drink, or are turned at once on the pasture, where the dip will run from their bodies on the grass and other vegetation, serious losses are liable

to result. Crowding the animals before they are dry should also be avoided, and they should not be driven any considerable distance within a week after dipping, especially in hot weather. If many repeated treatments are given the cattle should not be treated oftener than every two weeks.

In addition to properly protecting vats containing arsenical dip when not in use, another precaution must be observed when vats are to be emptied for cleaning. The dip should not be poured or allowed to flow on land and vegetation to which cattle or other animals have access. The best plan is to run the dip into a pit properly protected by fences, and the dip should not be deposited where it may be carried by seepage into wells or springs which supply water used on the farm.

The above precautions are given to inform persons not familiar with arsenic of its poisonous nature and the care that should be observed in its use, and to stimulate a proper care in those who know its poisonous nature and yet might be careless or who may not know all the precautions that should be observed. Unfortunately, however, the giving and emphasizing of such precautions have had the effect of arousing unwarranted fear of arsenic on the part of some stockmen and farmers, and have caused them, for a time at least, to refuse to undertake its use in treating cattle for ticks. For the benefit of those who may unduly fear arsenic because of what has been said, it should be stated that when reasonable care is observed in following the precautions given there is little danger of losses occurring. The arsenical dip has been extensively used during the past five years in tick-eradication work in the tick-infested area, and considering the number of cattle that have been dipped the losses have been very small. Some of these losses have been definitely traced to carelessness, and there is little doubt that if it had been possible to investigate all losses the majority of them would have been found to be due to this cause.

METHOD OF DIPPING.

The procedure to be followed in dipping animals on a farm depends on the end that is sought in undertaking the treatment. If it is simply desired to reduce and keep down the infestation of ticks on a farm, it will only be necessary for the owner to keep his animals under observation and dip them when, according to his judgment, treatment is necessary to keep the ticks under control. Such a procedure may well be followed where the regular tick eradication is not under way; that is, in instances in which it is not yet practicable or expedient to rid farms completely of ticks.

If, however, it is desired to rid the farm completely of ticks—and this should be the purpose in every case in which it is practicable and expedient—it will be necessary to dip all cattle, and also any horses,

mules, or asses that may harbor the cattle tick, at regular intervals until all ticks have disappeared from the farm. The purpose of such dipping is to prevent as nearly as possible any engorged females dropping to the pasture and there laying eggs which in time may develop into young ticks. In order to do this it is necessary to dip at intervals short enough so that no tick after getting on the cattle will have time to mature and drop off before the next dipping. An interval between dippings of two weeks is considered most satisfactory. This interval, however, may be increased somewhat if necessary, but it should never be greater than three weeks.

In freeing a farm of ticks the dipping should not be discontinued until it has been determined with certainty that the cattle and premises are free of ticks. It should be borne in mind that it is almost impossible to determine by a few inspections, even if carried out with great care, that animals are free from ticks. If the treatment is discontinued and a few unobserved ticks are still on the animals, these, on maturing and dropping, are likely to give rise to a new brood of young ticks. Moreover, even if the cattle are actually free from ticks, the fact should not be lost sight of that there may still be engorged females, eggs, and seed ticks on the premises. This is most likely to be the case during the colder part of the year when the development of the tick on the ground progresses slowly and also when any seed ticks that may be present are likely to be slow in reaching the cattle because of inactivity resulting from the low temperature.

SPECIFICATIONS FOR THE CONSTRUCTION OF A CONCRETE CATTLE-DIPPING VAT.

SITE.

The site selected for the location of the vat should be dry and of sufficient size to admit of the construction of the chute, the dripping pen, and at least two additional pens—one for holding the cattle prior to dipping and the other for retaining them after dipping until sufficiently dried.

EXCAVATION.

The excavation should be made 1 foot wider and 1 foot longer than the inside dimensions of the vat and should conform to its shape. The inside dimensions of the vat are shown on the drawings (fig. 1) and are as follows: Length at top of vat, 26 feet; bottom, 12 feet. Width at top, 3 feet; at bottom, 1½ feet. Depth, 6½ feet.

The sides and bottom of the excavation should be firm and solid, as they are to serve for the outside forms in casting the concrete. If it is necessary to do any filling in order to conform to the shape of the vat, the filling should be puddled and thoroughly rammed until solid, because the stability of the concrete depends on the foundation.

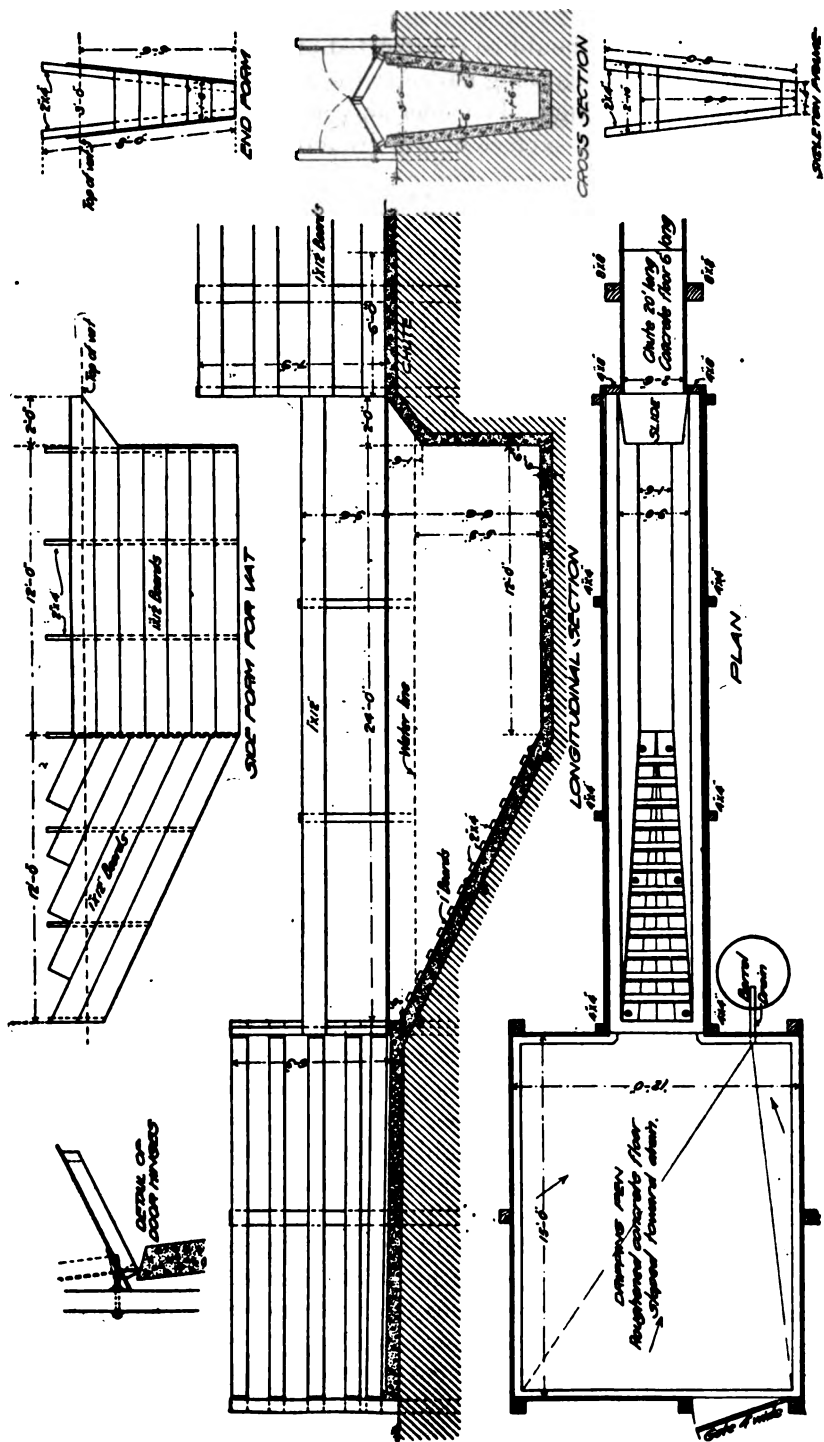


FIG. 1.—Plans for a concrete dipping vat.

FORMS.

The wooden forms should be constructed of 1-inch boards and 2 by 4 inch braces, the boards being nailed to the outside face of the braces, as shown in the drawings. The sides and end walls should be built 8 inches higher than the surface of the ground, which should be level.

CONCRETE.

The concrete should be made of 1 part of cement, by measure, $2\frac{1}{2}$ parts of sand, and 5 parts of broken rock or gravel. The cement should be of a standard brand of Portland, the sand clean and coarse, and the broken rock from about $\frac{1}{4}$ -inch pieces to not larger than will pass in every direction through a 1-inch ring.

Mixing.—The mixing should be done on a tight wooden platform or in a tight box. The sand and stone should be measured in a bottomless box, $2\frac{1}{2}$ feet long by 2 feet wide by 1 foot deep, having a capacity of 5 cubic feet. A convenient size of batch to mix is one consisting of 2 bags of cement, 1 measure (5 cubic feet) of sand, and 2 measures (10 cubic feet) of stone.

The sand is measured out first and the cement emptied on top, after which the two materials are thoroughly mixed together, dry. In the meantime the stone may be measured out and thoroughly drenched with water. The cement-sand mixture is mixed with water and the resulting mortar then combined with the stone. The stone should be shoveled on the mortar, which has been previously spread out in a thin layer. Mixing should continue until the stone is thoroughly coated with mortar, more water being added during the mixing process if necessary.

Laying.—Before laying the concrete the molds should be set and thoroughly braced into place. The side forms may be suspended in the excavation with their lower edges 6 inches from the bottom by means of crosspieces nailed to the uprights and of sufficient length to rest on supports located several feet from the edges of the excavation. The concrete for the bottom and incline is deposited first, this mixture being of a consistency that water will flush to the surface on ramming. The mixtures for the sides and end should be very wet and should be thoroughly puddled into place. The consistency of the concrete for the side walls should be such that it will run off the shovel unless handled quickly.

The laying of the concrete should be done, if possible, in one operation, in order that there may be no joints between the new and old work. If it becomes necessary to lay the concrete on two or more days the surface on which the new concrete is to be deposited should be washed thoroughly clean and coated with grout of pure Portland cement and water mixed to the consistency of cream. The new con-

crete should be placed before the grout has set. Extreme care should be taken to prevent dirt from falling in on top of the deposited concrete.

The forms should not be removed until the concrete is set, which in moderate weather will have taken place in about 24 hours. In damp, cold weather at least 48 hours should be allowed before removing the forms. It will be advisable, especially in water-soaked ground, to allow the forms to remain in place for one week before removal.

Finishing coat.—Before applying the surface coat dampen the walls and floor thoroughly. Cover the entire exposed surface of the floor and walls with a coating one-half inch thick of cement mortar composed of Portland cement 1 part, sand 2 parts. Coating to be floated and troweled to a smooth finish.

WATERPROOFING.

If the earth around the vat is thoroughly drained the vat may be waterproofed by painting the surface coat, but painting the surface will not give satisfactory results if there is ground water to seep in. The paint may be good hot pine tar, or gas-house tar cut with naphtha or gasoline and applied with a brush, or after the mortar coat has hardened the inside of the vat may be painted with an oil-cement paint made as follows:¹ Mix enough water with Portland cement to make a fairly stiff paste; add to this 5 per cent of heavy petroleum residuum oil based on the weight of the cement, and mix thoroughly until the oil entirely disappears, then add more water and stir until a paint of the consistency of cream is formed. This paint should be applied with a brush and should be well rubbed into the surface. Should the mortar coat be omitted the paint coat should be applied directly to the surface of the concrete.

EXIT INCLINE.

As the exit incline is to have a false wooden floor, it will be necessary to embed iron bolts in the concrete, to which the wooden floor may be fastened. Before the concrete incline is laid embed in the dirt three pieces of 2 by 4 inch scantling, placed at the top, center, and bottom of the incline. The bolts should extend through these pieces and should be placed with the head next to the dirt. The bolts should be long enough to extend through the concrete and the inch boards of the floor, so that the wooden floor may be securely fastened.

SLIDE.

Cover the slide with a sheet of boiler iron properly fastened to the cement.

¹ These directions for the oil-cement paint are furnished by the Office of Public Roads of the United States Department of Agriculture.

COVER.

The cover of the vat consists of two leaves hinged on posts set 3 feet in the ground along each side of the vat. The leaves are 2 feet 6 inches wide, and when open rest against the upper part of the posts to which they are hinged and serve as splash boards. The details of the hinge¹ used and the method of setting it are shown in the drawings. When the leaves are open their lower edges are just above the top of the side walls, which are given a slope inward for the purpose of conducting the dip running from the splash boards back into the vat. Removable doors should be constructed to close the triangular openings left at the ends of the vat when the cover is closed. The hinges may be made by a blacksmith.

DRIPPING PEN.

Construct a dripping pen about 12 by 15 feet at the head of the exit incline. The floor should be of concrete prepared as previously described for the vat and laid in a similar manner. The floor should be pitched toward a corner of the pen, where a pipe should be laid in the floor to carry the drippings into a barrel sunk in the ground. The drippings thus caught may be returned to the vat after settling. The floor should be roughened to prevent the cattle from slipping.

CHUTE.

The chute leading to the vat should be built 30 inches wide and 20 feet long, and the receiving and retaining pens should be of a size to take care of the animals to be dipped.

BILL OF MATERIALS FOR VAT, DRIPPING PEN, AND CHUTE.

LUMBER FOR FORMS.

- 8 pieces 1 by 12 inches by 14 feet long.
- 13 pieces 1 by 12 inches by 12 feet long.
- 2 pieces 1 by 12 inches by 9 feet long.
- 2 pieces 1 by 12 inches by 6 feet long.
- 2 pieces 1 by 12 inches by 4 feet long.
- 8 pieces 2 by 4 inches by 8 feet long.
- 2 pieces 2 by 4 inches by 7 feet long.
- 2 pieces 2 by 4 inches by 6 feet long.
- 2 pieces 2 by 4 inches by 4 feet long.
- 2 pieces 2 by 4 inches by 2 feet long.
- 7 pieces 1 by 6 inches by 12 feet long for crosspieces for inside of forms.

LUMBER FOR DRIPPING PEN.

- 7 pieces 6 by 6 inches by 10 feet long for posts.
- 10 pieces 1 by 8 inches by 16 feet long for side rails of pen.
- 5 pieces 1 by 8 inches by 12 feet long for side rails of pen.
- 5 pieces 1 by 8 inches by 8 feet long for side rails of pen.

¹ This hinge and the method of setting it for the cover of a dipping vat have been copied from an article by William Taylor Heslop in the *Agricultural Journal of the Union of South Africa*, Pretoria, vol. 1, No. 1, 1911, pp. 38-43.

The covers can be made from the lumber used in making the forms, and the lumber for the exit incline can be gotten in the same way.

The 4 by 4 inch posts to which the cover is hinged may be made from 2 by 4 stuff by spiking together.

End form to be made solid.

HARDWARE AND IRONWORK.

6 bolts, $\frac{1}{2}$ by 10 inches, with nuts and washers, for false floor of incline.

1 sheet of $\frac{1}{4}$ -inch boiler iron cut to shape of slide; plate bored and counter-sunk for four screws.

4 pairs hinges for covers.

3 heavy T hinges and screws for gate of dripping pen.

1 heavy iron bolt to fasten gate.

CONCRETE.

VAT.

Cement, 10 $\frac{1}{2}$ barrels (42 bags).

Sand, 3 $\frac{1}{2}$ cubic yards.

Stone, 6 $\frac{1}{2}$ cubic yards.

DRIPPING PEN AND CHUTE.

Cement, 5 $\frac{1}{2}$ barrels (22 bags).

Sand, 1 $\frac{1}{2}$ cubic yards.

Stone, 3 $\frac{1}{2}$ cubic yards.

A 26-foot vat has been used extensively for eradication purposes with satisfactory results. However, if it is desired to lengthen the body of the vat on account of large numbers of cattle to be treated, or to make it conform to the bureau's requirements for the treatment of cattle for movement as noninfectious, there should be added to the amount of concrete material for each lineal or running foot, cement, 0.37 barrel; sand, 0.12 yard; stone, 0.24 yard.

By some a dripping chute is regarded more satisfactory than a dripping pen. One of the advantages that it has is that the cattle are held in line in the order in which they have been dipped, thus making it possible to remove one or more of them at a time as soon as they have drained sufficiently, in order to make room for others. In using the dripping pen this is not practicable and it is necessary to wait until the last animal dipped has drained sufficiently and then remove them all together.

In case it is desired to construct a dripping chute it should be located at the head of the exit incline in line with the vat. It should be about 36 inches wide. The length will depend on the number of cattle it is desired to accommodate at one time, it being necessary to allow 4 to 5 feet for each. A length of from 20 to 40 feet is considered a convenient size for small herds. The floor should be made of concrete and sloped toward the vat. The dip should not be permitted to run directly into the vat, but should be collected in a barrel to settle, as shown in the case of the dripping pen. The floor at the sides should be raised about 2 inches in the form of a curb to keep the dip from running off.

Issued April 23, 1912.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.—CIRCULAR 184.

A. D. MELVIN, CHIEF OF BUREAU.

THE PASTEURIZATION OF MILK.

BY

S. HENRY AYERS,
Bacteriologist, Dairy Division.



• WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

ORGANIZATION OF THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.

Assistant Chief: A. M. FARRINGTON.

Chief Clerk: CHARLES C. CARROLL.

Animal Husbandry Division: GEORGE M. ROMMEL, chief.

Biochemic Division: M. DORSET, chief.

Dairy Division: B. H. RAWL, chief.

Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, associate chiefs.

Pathological Division: JOHN R. MOHLER, chief.

Quarantine Division: RICHARD W. HICKMAN, chief.

Zoological Division: B. H. RANSOM, chief.

Experiment Station: EL. C. SCHROEDER, superintendent.

Editor: JAMES M. PICKENS.

DAIRY DIVISION.

B. H. RAWL, *Chief.*

HELMER RABILD, *in charge of Dairy Farming Investigations.*

S. C. THOMPSON, *in charge of Dairy Manufacturing Investigations.*

L. A. ROGERS, *in charge of Research Laboratories.*

ERNEST KELLY, *in charge of Market Milk Investigations.*

ROBERT MCADAM, *in charge of Renovated Butter Inspection.*

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 3, 1911.

SIR: I have the honor to transmit herewith, and to recommend for publication as a circular of this bureau, the accompanying manuscript, entitled "The Pasteurization of Milk," by S. Henry Ayers, bacteriologist in the Dairy Division of this bureau.

Efficient pasteurization is a safe means of guarding against infection, and when the temperature of pasteurization is not excessive this process probably causes no injury to the quality or appearance of the milk. Pasteurization also enhances the keeping properties, though the ordinary grades of milk when properly pasteurized under commercial conditions will still sour. It is especially valuable as a means of rendering reasonably safe the ordinary market milk, much of which would otherwise be dangerous to health; yet pasteurization is not to be regarded as a substitute for cleanliness, and its use as an attempt to hide the defects of dirty or otherwise unfit milk should not be countenanced.

Pasteurization in the final container which is received by the consumer is the ideal method, as in this way there is no danger of the milk becoming infected between the time of pasteurization and the time of its receipt by the consumer. This method has not yet been found practicable for general commercial use, however, chiefly on account of its expense and the lack of suitable machinery; but efforts are being made to adapt it to such use.

When one considers the enormous quantity of milk which is necessary to supply a large city, and the large number of producers from whom the milk must come, it is realized that the opportunities for contamination are very great. On this account raw milk for a city milk supply should be the exception rather than the rule, and such milk should be permitted to be sold only when there is the very closest supervision with regard to the health of the cows and attendants and the cleanliness of premises, equipment, and methods of handling the milk.

Milk dealers, dairymen, and farmers generally should profit from the full information which is given in this paper regarding the various methods of pasteurization. The paper also includes descriptions and illustrations of a number of the best types of machines adapted for the work both on the farm and in plants where large quantities of milk are handled.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Meaning of the term "pasteurization"	7
Value of pasteurization	7
Quality of the milk to be pasteurized	8
Methods of pasteurization	8
The "flash" process	9
The "holder" process	9
Advantages of the holder process	10
Pasteurization in bottles	10
Bottling pasteurized milk while hot	11
Selection of machinery	12
The pasteurizers	12
Holding tanks, retarders, etc.	17
Machinery for pasteurizing in sealed bottles	25
Coolers	28
Bottling and capping machines	32
Pasteurization on the farm	33
Construction and arrangement of pasteurizing plants	34
Care of machinery	36
The cleaning of milk bottles and cans	38
Controlling the process of pasteurization	40
Temperatures and methods to be used	42
Handling and delivery of pasteurized milk	43

ILLUSTRATIONS.

	Page.
Fig. 1. General arrangement of machinery for pasteurizing milk.....	9
2. A simple type of pasteurizer.....	13
3. Another simple pasteurizer.....	14
4. Conical type of simple pasteurizer.....	15
5. A simple pasteurizer through which milk flows by gravity.....	16
6. A double-tube milk heater (see also figure 28).....	17
7. A "regenerative" pasteurizer for use without holding tank.....	18
8. A regenerative pasteurizer for use with holding tank.....	19
9. Combination heating, holding, and cooling tank.....	20
10. Another type of heating, holding, and cooling tank.....	20
11. Holding tank with automatic emptying device.....	21
12. Showing compartments and milk outlets of tank in figure 11.....	22
13. A tubular milk retarder.....	22
14. A vertical tank retarder.....	23
15. Tank retarder with compartments.....	24
16. Tank retarder with automatic outlet.....	24
17. A single-wall milk tank converted into a simple holding tank.....	25
18. Showing method of operating tank in figure 17 with pasteurizer.....	25
19. Arrangement of hand control for filling and emptying tank in figure 17.....	26
20. A type of beer-pasteurizing machine adaptable to the pasteurization of milk in bottles.....	27
21. Another beer-pasteurizing machine adaptable to milk pasteurization.....	28
22. Simple type of vertical milk cooler.....	29
23. Regenerative type of milk cooler.....	30
24. Sectional view of another type of regenerative cooler.....	31
25. Regenerative device for use with simple cooler.....	32
26. A cylindrical inclosed cooler.....	33
27. A three-compartment disk cooler.....	34
28. A double-tube cooler, as operated with double-tube heater shown in figure 6.....	35
29. A starter can, suitable for pasteurizing on the farm.....	36
30. Steam chamber, showing method of steaming bottles.....	39
31. An automatic system of temperature control.....	41
32. Temperature chart, showing temperature recorded during pasteuriza- tion (holder process) from 7.45 a. m. to 11.35 a. m.....	42

THE PASTEURIZATION OF MILK.

MEANING OF THE TERM "PASTEURIZATION."

Pasteurization as applied to milk is the process of heating for a short or long period as the different methods demand at temperatures usually between 140° and 185° F. The process must be followed by rapid cooling. The term originated from the experiments of Pasteur, in France, from 1860 to 1864, on the "diseases" of wine, in which he found that heating for a few moments at a temperature of 122° to 140° F. was sufficient to prevent abnormal fermentations and souring in the wine. A little later Pasteur found that by a similar heating beer could be preserved from souring. The application of the process gave rise to the term "pasteurization."

VALUE OF PASTEURIZATION.

The value of pasteurization from a sanitary standpoint is of the greatest importance when market milk is under consideration.

In the first place, the pasteurization of milk, when the process is properly performed, affords protection from pathogenic organisms. Such disease-producing bacteria as *Bacillus tuberculosis*, *B. typhi*, *B. diphtheriae*, and the dysentery bacillus are destroyed, or at least have lost their ability to produce disease, when heated at 140° F. for 20 minutes or more. Although the infective agent in scarlet fever is unknown, epidemics of the disease have been traced to milk supplies, and in such cases pasteurization has been resorted to as a means of safeguarding the public, with apparently satisfactory results.

In the second place, pasteurization causes a reduction of the infantile death rate due to the ordinary intestinal disturbances. Numerous experiments definitely prove the value of pasteurization in this connection. While it has not been possible to isolate any special organisms which act as the causative agents in the common infantile intestinal troubles other than the one producing dysentery, it seems that high bacterial numbers in the milk consumed are associated with such diseases.

In the third place, pasteurization is of value from a commercial standpoint in so far as it increases the keeping quality of the milk and prevents financial losses caused by souring. Commercial pasteurization as practiced at the present time with reasonable care destroys

about 99 per cent of the bacteria, but it does not prevent the ultimate souring of milk, although it does delay the process.

Many objections have been raised to pasteurization. These are discussed fully in Bulletin 126 of the Bureau of Animal Industry of this department.

QUALITY OF THE MILK TO BE PASTEURIZED.

Only clean milk should be pasteurized, and it should never be pasteurized more than once. Dirty milk containing many millions of bacteria per cubic centimeter is not fit for consumption, and should be condemned. Pasteurization should not be resorted to in order to make dirty milk sweet long enough to be sold or simply to pass legal regulations, but should be used only to make clean milk a safe milk.

Milk to be considered clean should be produced in barns free from manure and floating dust. The cows should be curried every day, and their flanks and udders wiped with a damp cloth just before milking. The milkers should wear clean suits, and their hands should be clean and dry. All milking utensils should be cleaned and partly sterilized by steam or boiling water. After milking the milk should be removed at once to a milk house to be cooled, and it should be kept cool during delivery. A farm producing milk under the above conditions would score at least 70 points according to the score card of the Dairy Division.

METHODS OF PASTEURIZATION.

Milk is pasteurized by two processes, one known as the "flash" or "continuous" process, in which the flowing milk is heated to the required temperature and held there from 30 seconds to 1 minute. The other is known as the "holder" or "holding" process, and sometimes the term "held pasteurization" is applied. By the latter method the milk is held for approximately 30 minutes at the temperature desired.

The general arrangement of the machinery used in pasteurization is shown in figure 1. The sketch shows the use of one milk pump, which makes almost a gravity system. It is seen that the pasteurizer and holding tank are placed on a higher level than the cooler and bottling machine, so that after the milk is pumped to the supply tank it will flow by gravity through the whole system.

Before heating, milk is often filtered through absorbent cotton, sand, or quartz filters. The cotton will remove only coarse particles of dirt, while the sand and quartz filters, if properly operated, will remove some of the sediment from the milk. The desirability of the use of filters is not to be discussed in this paper, but when such filters are used they should be placed in the system between the receiving tank and the pasteurizer. In some plants the milk is clarified by

being separated and then mixed again before pasteurizing, this being done to remove particles of dirt, the greater part of which will remain in the separator. When the milk is to be separated it should flow from the receiving tank to a milk heater, where it is heated to 100° F., then to the separator which empties into the supply tank for the pasteurizer. The use of a separator does not decrease the bacteria; in fact, it apparently increases the bacterial content of the milk. The increase is not an actual one, however, but is due to a breaking up of the clumps of bacteria so that when a bacterial determination is made, instead of a clump of bacteria developing as one colony on a plate, the clump has been broken up into a number of individual organisms, each of which appears later as a separate colony. When each colony is counted and is assumed to represent one organism in the milk, obviously the bacteria are apparently increased by the process of separation of the milk.

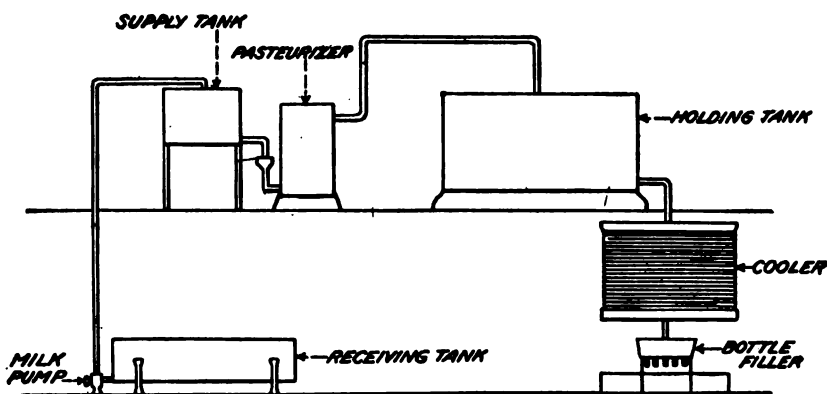


FIG. 1.—General arrangement of machinery for pasteurizing milk.

THE "FLASH" PROCESS.

The method of pasteurizing by the flash process is as follows:

The milk flows from the receiving tank to the pasteurizer, where it is heated at temperatures from 160° to 165° F. for from 30 seconds to 1 minute. After heating it flows to the cooler, where it is cooled to from 35° to 45° F., and is then immediately bottled and placed in refrigerators at temperatures ranging from 35° to 45° until time for distribution.

THE "HOLDER" PROCESS.

The holder process is the same as the flash process, except in the temperatures used and the length of the heating period. The milk is heated in the same pasteurizer as in the flash process, but at lower temperatures—140° to 150° F. After being heated it flows to the

holding tank, as shown in figure 1, where it is held for approximately 30 minutes, and is then cooled and bottled as in the flash process.

ADVANTAGES OF THE HOLDER PROCESS.

The holder process possesses numerous advantages over the flash process. To insure a complete destruction of disease-producing organisms with the holder process a temperature of 140° F. for 30 minutes is sufficient. With the flash process a temperature of 160° F. or higher is required to accomplish the same result. A much higher percentage reduction of bacteria can be obtained with the holder process than is possible with the flash process unless very high temperatures are used, and the bacterial reductions will be more uniform in the holder process, due to the heating of all the milk to the required temperature. When using a flash machine it is often found that the percentage bacterial reduction is greatly lowered, even though the temperature is carefully maintained. Such an occurrence is due to the fact that all of the milk is not heated to the temperature indicated by the thermometer. Again, the use of the high temperatures necessary for efficient results by the flash process is objectionable on account of the cooked taste produced in the milk, and because of the reduction of the cream line and the possibility of some chemical alteration of the milk. With the lower temperatures of the holder process no cooked taste is produced, there is no noticeable reduction of the cream line, and only slight chemical changes, if any at all, take place. Finally, the use of lower temperatures is preferable, from a financial standpoint, as they effect a saving in the cost of steam for heating and in refrigeration for cooling.

PASTEURIZATION IN BOTTLES.

Milk is at present pasteurized in bottles on a small scale, especially at the infant milk depots. In these cases small feeding bottles are filled with milk, then corked and placed in a chamber where the milk is raised to the pasteurizing temperature either by steam or by hot water. The milk is then cooled gradually by placing the bottles in water at lowered temperatures until they can be placed in ice water.

This method of pasteurization in bottles has not been used as yet in this country on a large scale. Recently Dr. Charles E. North¹ has suggested that the process is entirely practical on a commercial scale. He points out that milk may be pasteurized in corked bottles in the same type of machine in which bottled beer is pasteurized. Milk pasteurized by this method would be free from any possibility of reinfection from the time of pasteurization until it reached the consumer. If this method can be practiced with speed and economy

¹ Medical Record, vol. 80, no. 3, p. 111.

it will undoubtedly prove superior to all others. Numerous processes have been patented, and one machine is being manufactured to pasteurize milk in the sealed bottle. Doubtless the method will gain in popularity as its merits are recognized, but pasteurization in sealed bottles makes necessary an entirely new equipment in a milk plant. It is doubtful if a company which has \$20,000 to \$30,000 worth of modern pasteurizing machinery in its plant will feel justified or even inclined to make a change which means the discarding of its expensive equipment only to have to replace it with expensive machinery of another type.

BOTTLING PASTEURIZED MILK WHILE HOT.

In order to avoid entirely new equipment for pasteurizing and at the same time accomplish practically the same results as in bottle pasteurization the bottling of milk while hot is suggested. This process is in an experimental state and will be the subject of further study in the research laboratories of the Dairy Division.

The process may be outlined as follows: The milk after being pasteurized by the holder process at 145° or at 150° F. is bottled and capped without cooling and allowed to stand until the temperature has dropped to 130° F., which requires about 15 minutes, varying with the temperature of the air. The bottles are then cooled by placing in ice water. With this method of bottling the milk while hot the process of pasteurization is completed in the bottle, thus destroying pathogenic organisms which might have infected the bottle; in other words, practically pasteurizing the bottle after capping. In our experiments we have found that bottles may be filled with hot milk at 150° F. and even higher, then placed at once in ice water without breaking. When milk at a temperature of 150° F. is placed in a bottle and capped the temperature drops to 140° F. in about 10 minutes at ordinary room temperature. There is therefore 10 minutes' pasteurization in the bottle at a temperature above that usually considered effective for pasteurization. The length of the heating in the bottle may be increased by holding the bottle of hot milk in a warm room. The bottles of hot milk may be handled on mechanical conveyers which carry them for the holding period and then be cooled by having the conveyer run through tanks of ice water. Ordinary caps may be used, but in that case care must be taken to see that the ice water does not reach the top of the bottle. With the use of crimped metal-capped cork seals the bottles are rendered water tight and can then be submerged in ice water for cooling. When milk is bottled hot there is a slight shrinkage on cooling, which, however, is of no great importance.

The only equipment necessary to adapt this method to the holder process of pasteurization is a conveyer and a cooling tank. The

mechanical details of the process depend only on the output of the milk plant and may be widely varied. It is believed that this method of bottling milk while hot will make it possible to achieve practically the same results as bottle pasteurization without necessitating the purchase of an entirely new equipment.

SELECTION OF MACHINERY.

THE PASTEURIZERS.

There are numerous pasteurizers on the market, for which the respective manufacturers claim various merits. In selecting a machine one should consider the various types carefully. Two points in particular should be kept in mind, namely, the simplicity of the machine and the ease with which it may be cleaned. A pasteurizer with inaccessible parts or one which requires considerable time to take apart for cleaning should never be used. The machine should be constructed so as to use hot water for the heating agent instead of direct live steam. Milk is usually heated by being forced against or circulated over hot surfaces, and when steam is used the milk may leave the machine at the desired temperature, say 160° F., but certain portions may be forced against a very hot part of the heating surface and be heated above that temperature. Such milk will be neutralized by milk not heated so high, so that the whole may give the required temperature of 160° F. Such heating, however, produces a scorched milk and will reduce the cream line to a considerable extent. On the other hand, when hot water is used for heating, the heating surface can be kept at a constant temperature. The water in the pasteurizer is heated by steam introduced into the water jacket or circulating water system, depending on the type of machine.

When purchasing a pasteurizer, one of larger capacity than is required by the milk supply should be selected. If a machine of small capacity is used for a large supply the milk must be forced through more rapidly than is normal for the machine. This makes the use of hotter heating surfaces necessary to give the pasteurizing temperature and results in the overheating of the milk, thereby producing a scorched product with a reduced cream line.

There are numerous pasteurizers on the market, the construction and method of operation of which are in a very general way discussed in the following pages. The drawings are not intended to show the exact construction of the machines, but are merely to show the principles of operation.

The construction of one of the simple types of pasteurizer is shown in figure 2. This machine consists of a milk chamber with revolving paddle, which is surrounded by a steam and water jacket. When the steam is turned on preliminary to heating the milk it enters the

jacket through three sets of jets, which may be seen joining the steam pipe. The steam condenses and the jacket is soon filled with water so that the milk is heated by hot water, the temperature of which is maintained by the jets of steam. The milk flows into the pasteurizer through the milk inlet at the bottom and is thrown by the centrifugal action of the revolving paddle against the sides of the hot-water jacket, and is then forced out at the top through the

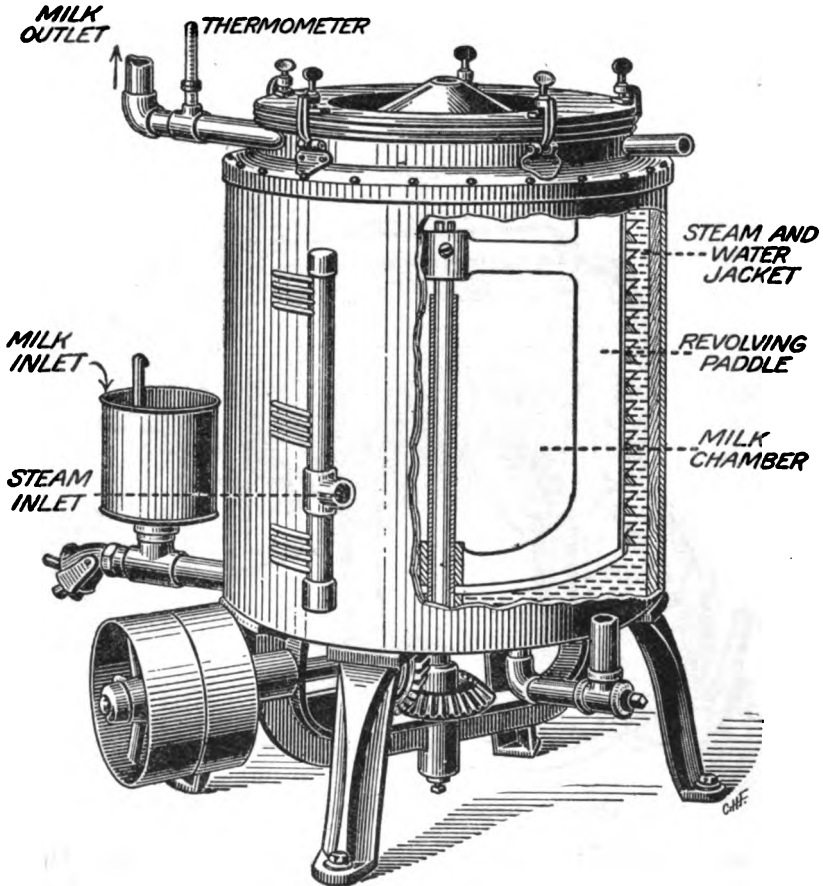


FIG. 2.—A simple type of pasteurizer.

milk outlet pipe. The temperature of the milk is shown by a thermometer as it leaves the machine. Pasteurizers of this type will force the milk to a height of 4 feet above the machine, which makes them convenient to use when it is necessary to elevate the milk to a holding tank or cooler.

Another type of simple pasteurizer is shown in figure 3. The machine consists of a water-jacketed cylinder, inside of which revolves

a drum. The water is heated by a steam discharge into the water pipe connecting with the water jacket. When in operation the milk enters through the milk inlet and is drawn by the centrifugal action of the revolving drum over it between its surface and the hot-water jacket, and is forced out through the milk outlet. A machine of this type will also elevate milk several feet.

Figure 4 shows a conical type of simple pasteurizer. This machine consists of a conical heating drum, over which revolves a skeleton frame carrying a tape which constantly wipes the heating surface. Steam is introduced at the bottom of the drum through standing

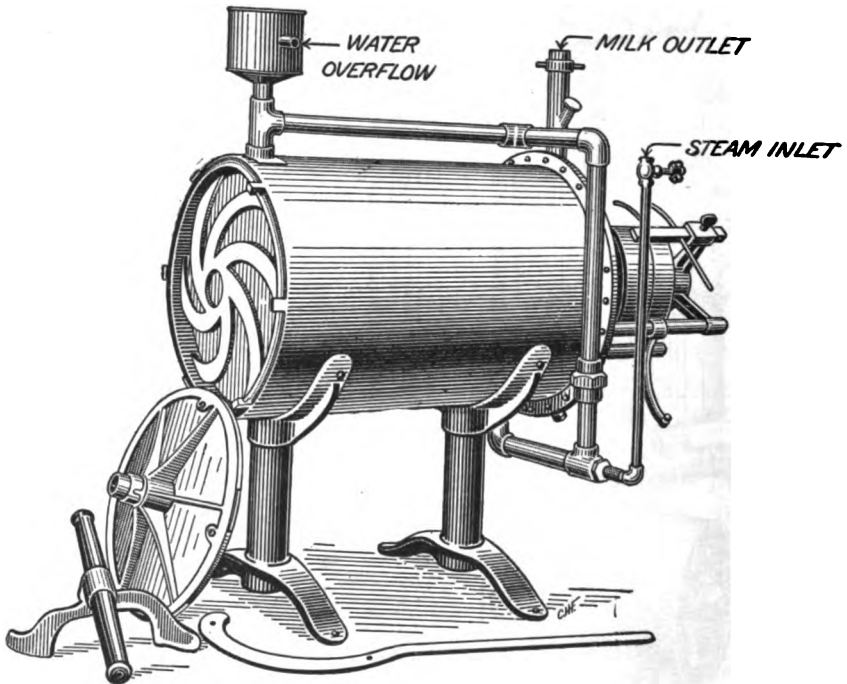


FIG. 3.—Another simple pasteurizer, showing cover removed.

water and is forced through it up against the heating drum. During the operation of the machine the milk enters at the top and passes through holes in the bottom of the reservoir down over the heating drum. The revolving tape keeps the milk from burning on the drum and keeps the surface of the latter clean. When the milk reaches the bottom of the heating drum it is caught in a trough and is then pumped to the holding tank or cooler.

In figure 5 is shown a type of simple pasteurizer through which milk flows by gravity. The milk enters at the top and flows down through the milk space, as shown in the drawing, and is forced by its own weight up through the outer milk space to the top of the pas-

teurizer, where it is caught in a trough connecting with the outlet pipe. The milk space is surrounded by a hot-water jacket which heats the milk during its passage. A pasteurizer of this type does not require any machinery to operate it.

A different type of simple milk heater is shown in figure 6. This is known as an internal or double-tube apparatus. It is simply a

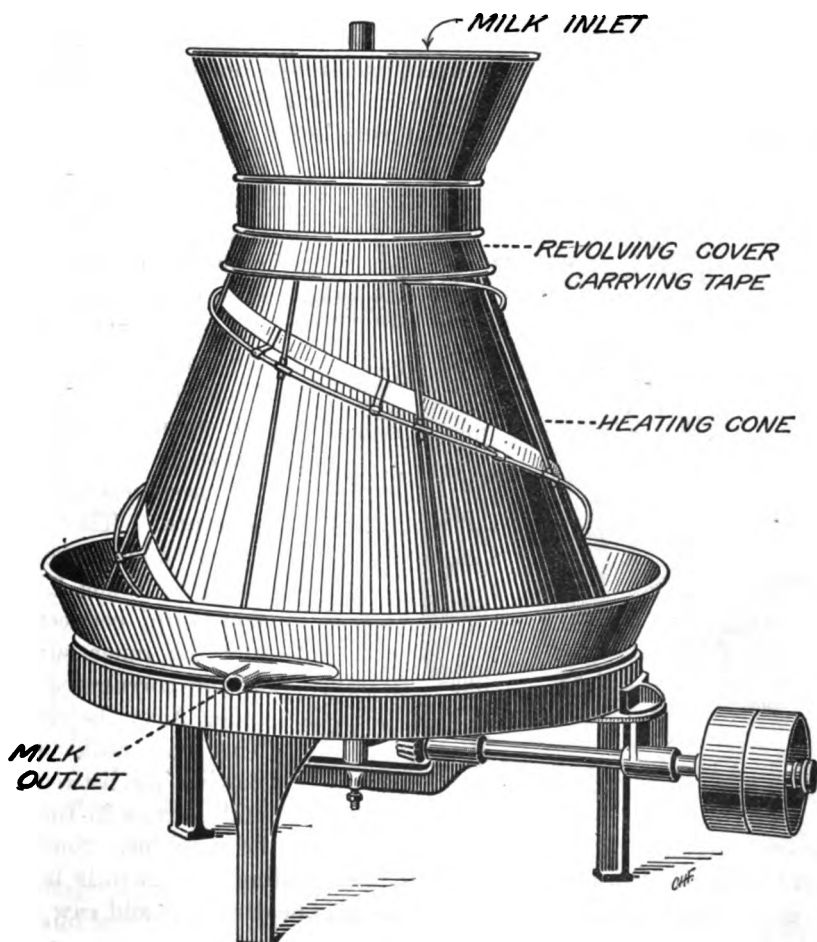


FIG. 4.—Conical type of simple pasteurizer.

series of double-tube pipes, through one of which flows hot water and through the other milk. The water is heated by a steam jet introduced into the water line before it connects with the heating coil. When in operation the milk flows through the inner of the double tubes in the opposite direction to the incoming hot water. The end connection between pipes is constructed so as to be easily removed to facilitate cleaning. The pipes are also built to stand pressure so that

steam under pressure can be used for sterilizing the apparatus. The heater is constructed in sectional units of eight double pipes 8 feet long. By this sectional unit system the capacity of plants may be increased as the requirements demand by the use of additional units.

Several pasteurizers are known as "regenerative" machines. The regenerative principle consists in warming the milk to be pasteurized by allowing it to flow against the hot pasteurized milk, thus cooling the hot milk before it goes to the cooler. In other words, there is a transfer of heat from the hot milk which is to be cooled to the cold milk which is to be heated. A section through one type of regenerative pasteurizer is shown in figure 7. The milk to be pasteurized is discharged into H, from which it runs over the corrugated casing

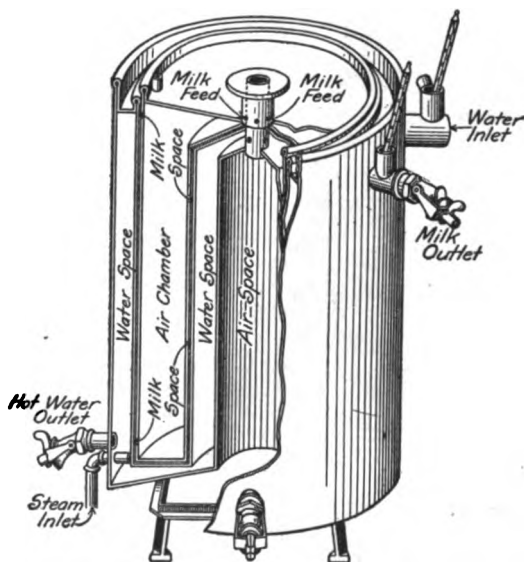


FIG. 5.—A simple pasteurizer through which milk flows by gravity.

A, where it is heated. The milk is caught in the trough B and pumped through the pipe C into the top of the inner cylinder of the pasteurizer, and from there flows over the steam chamber D, where it is heated to the pasteurizing temperature. The milk passes under the rotating cylinder E and flows up between it and the inner surface of the corrugated cylinder A to the cooler. The hot milk while flowing up between E and A runs in the op-

posite direction to the cold milk entering the machine. Such an arrangement causes an exchange of heat, cooling the hot milk before it goes to the cooler, and at the same time heating the cold raw milk which is to be pasteurized.

Other types of regenerative pasteurizers differ slightly in construction, but the regenerative principle is the same in all cases.

When a holding tank is used the construction of the regenerative pasteurizer has to be slightly changed. The milk is heated and without being cooled is conveyed to the holding tank, from which it flows back to the pasteurizer and from it to the cooler. A section through a machine of this type is shown in figure 8. The course of the milk during the operation of the pasteurizer may be traced from

the drawing. It enters at the top from the feed tank and flows down over two corrugated surfaces, A and B, to the bottom of the machine. There the milk is heated to the desired temperature by being forced by an agitator against the sides of a steam and water jacket. It is then forced to the holding machine, from which, after being held for the proper length of time, the milk flows back to the pasteurizer and is run through the space between the surfaces A and B and then to the cooler. When passing up through these surfaces the hot milk flows against the cold milk which is to be pasteurized, and during its passage the cold milk is heated and the hot milk cooled. The

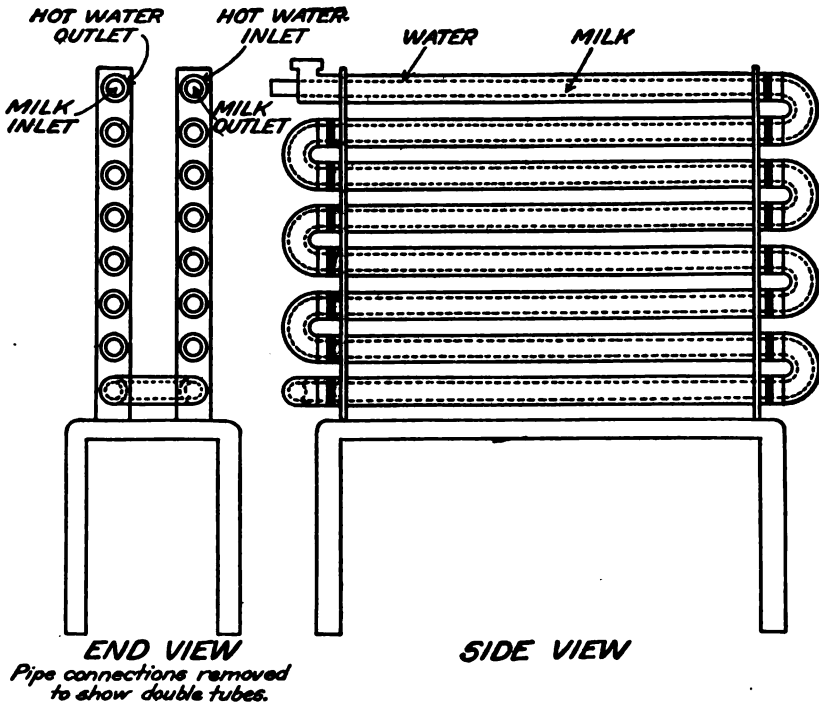


FIG. 6.—A double-tube milk heater. (See also figure 28.)

advantage of the regenerative system is in the use of less steam to heat and less brine to cool the milk.

HOLDING TANKS, RETARDERS, ETC.

Numerous holding tanks and retarders have been designed since the introduction of the holder process of pasteurization. The holding tanks actually hold all the milk the required time, 20 to 30 minutes—that is to say, the flow of milk is stopped and the period of holding dates from that time. Retarders are constructed so that the milk flow is not stopped, but is so retarded that theoretically the

milk is held for the required period. But when retarders are used there is always the possibility of some milk passing directly through without being held the proper length of time. For this reason it seems highly desirable to use apparatus in which there can be no question as to the holding period of all the milk.

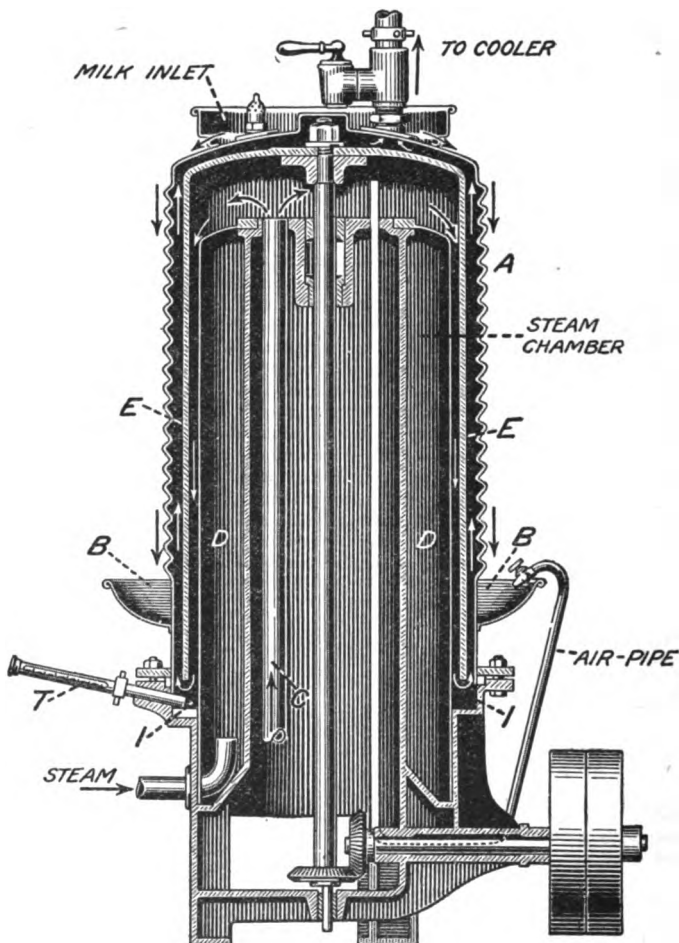


FIG. 7.—A "regenerative" pasteurizer for use without holding tank.

Recently there has appeared upon the market a combination heating, holding, and cooling tank, the arrangement of which is shown diagrammatically in figure 9. This apparatus consists of an insulated tank built in capacities from 1,000 pounds up, in which revolves a spiral agitator carrying hot water for heating and cold water and brine for cooling. The tank is filled with the milk to be pasteurized, and during the filling it is being heated. When the tank is filled,

which takes 30 minutes, the milk is at the desired temperature and the heating is stopped. The milk is heated by circulating hot water, by the aid of a pump, from the water tank around through the revolving spiral heating coil.

Steam to heat the water is blown into the circulating system near the pump. After allowing the milk to stand at the pasteurizing

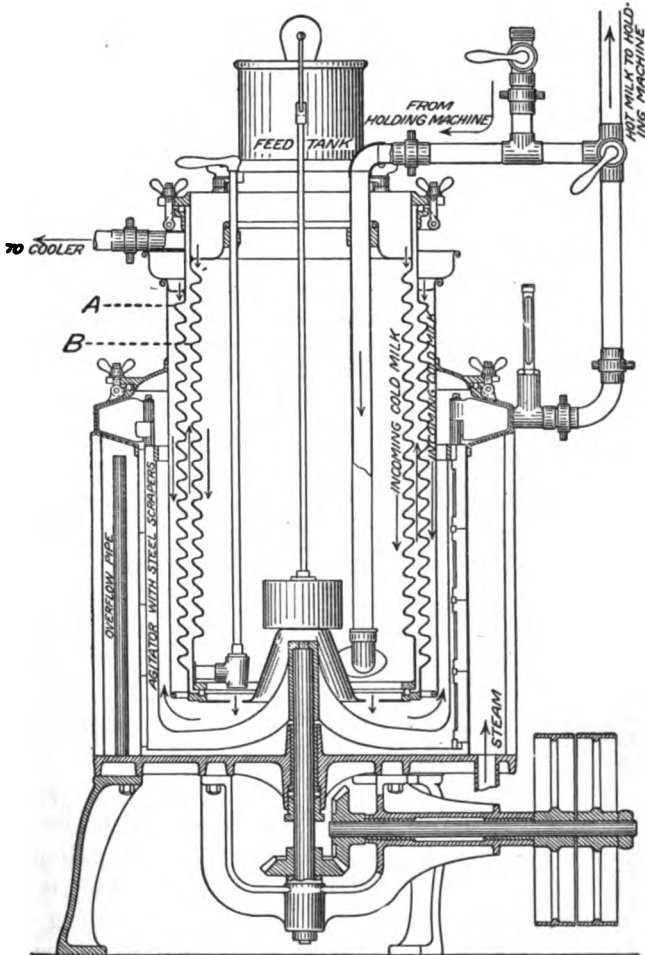


FIG. 8.—A regenerative pasteurizer for use with holding tank.

temperature for 30 minutes the hot water is replaced by cold water and the cooling process is started. When the temperature of the pasteurized milk is reduced as far as possible with the cold water, brine is then circulated through the coil and the cooling is completed. This process requires 30 minutes, making a total of $1\frac{1}{2}$ hours for the complete process. To furnish brine for the cooling ice and salt may be placed in the water tank, or if there is a refrigerating

system in the plant a brine coil may be inserted in the water tank. These tanks are provided with covers which should always be in

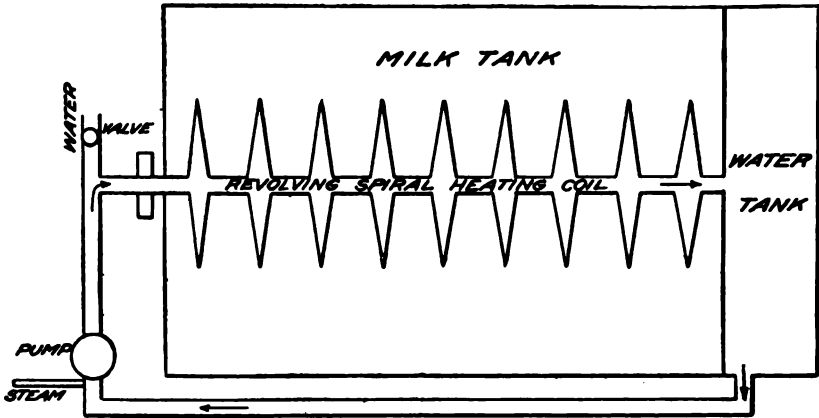


FIG. 9.—Combination heating, holding, and cooling tank.

place during the operation of the machine. A recording thermometer is provided so that the temperature of heating, the length of time of holding, and the cooling temperature may be recorded.

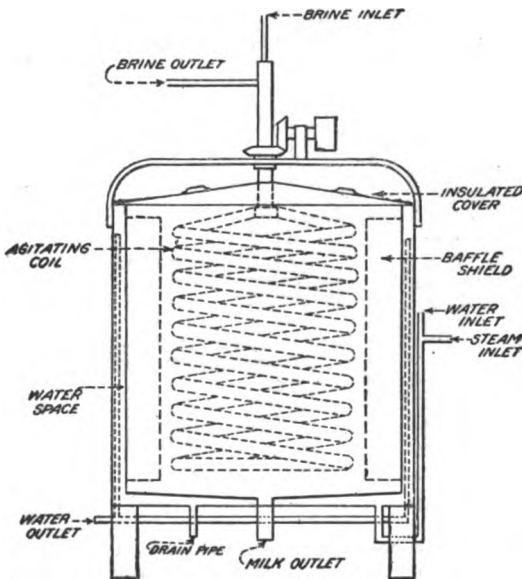


FIG. 10.—Another type of heating, holding, and cooling tank.

In figure 10 another type of apparatus for heating, holding, and cooling is shown. This type of construction eliminates any of the bearings coming in contact with the milk. The machine consists of a tank with steam and water jacket made in capacities from 150 to 500 gallons. Inside of the tank is suspended an agitating coil of the endless type through which brine may be circulated. The hot-water jacket furnishes the heat required, and the milk is circulated

by means of the agitator, which, with the assistance of the baffle plates, gives a good circulation. After the milk has been heated and allowed to stand, the cooling process can be started by replacing

the hot water in the jacket with cold water. The process may then be completed by a flow of brine through the agitating coil. This machine also is supplied with insulated covers.

If a plant has a large amount of milk to pasteurize, several of either of these types of tanks may be used to simply heat and hold the milk, the cooling being done by the ordinary types of coolers.

A form of holding tank which simply holds the hot milk is shown in figure 11. This tank is divided into eight compartments, as shown in figure 12. Each compartment has an outlet valve at the bottom operated by an arm connected with the center shaft which passes up through the machine and makes one revolution in 30 minutes. At the top of the shaft is a distributing trough, which fills the eight compartments in 30 minutes. The emptying device is so arranged that six compartments are always filled—one is being filled and one being emptied. By this arrangement one compartment after being filled with hot milk is closed for approximately 30 minutes before it is emptied automatically onto the cooler. The compartments are so arranged as to be completely filled when the machine

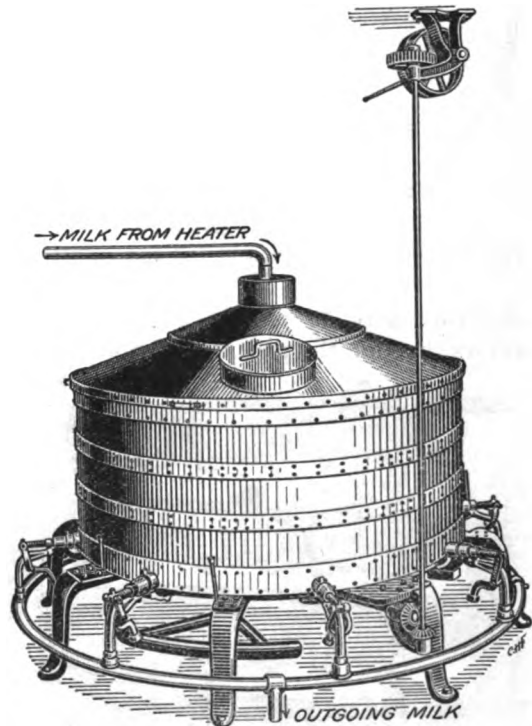


FIG. 11.—Holding tank with automatic emptying device.

is going at full capacity; at one-half capacity they would be one-half full. They can therefore be used with small pasteurizing machines.

The retarders which are in use vary considerably in construction, although the principle is the same. Figure 13 shows a tubular retarder which consists of a series of tubes of sufficient length so that the hot milk from the pasteurizer flowing in at one end takes 30 minutes to reach the other end. The milk flows in at the bottom and out at the top. Connections between the tubes as shown in the figure are of such a nature as to be easily opened to facilitate the cleaning of the apparatus.

A tank retarder is shown in figure 14. This is simply a tank with the milk inlet at the top and the outlet pipe running from the bottom

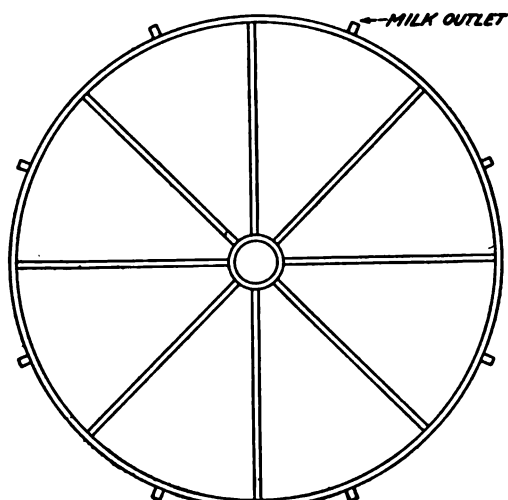


FIG. 12.—Showing compartments and milk outlets of tank in figure 11.

up to nearly the top of the tank. By this arrangement the tank does not begin to empty until the level of the milk in the tank has reached the highest point of the outlet pipe. After reaching that point the flow is continuous. When the flow of incoming milk is stopped the remaining milk in the tank is allowed to run out by opening the valve A.

Another type of tank retarder is shown in figure 15, where the construction may be plainly seen. When in operation the hot milk enters through the pipe A and is conducted to the bottom of the first

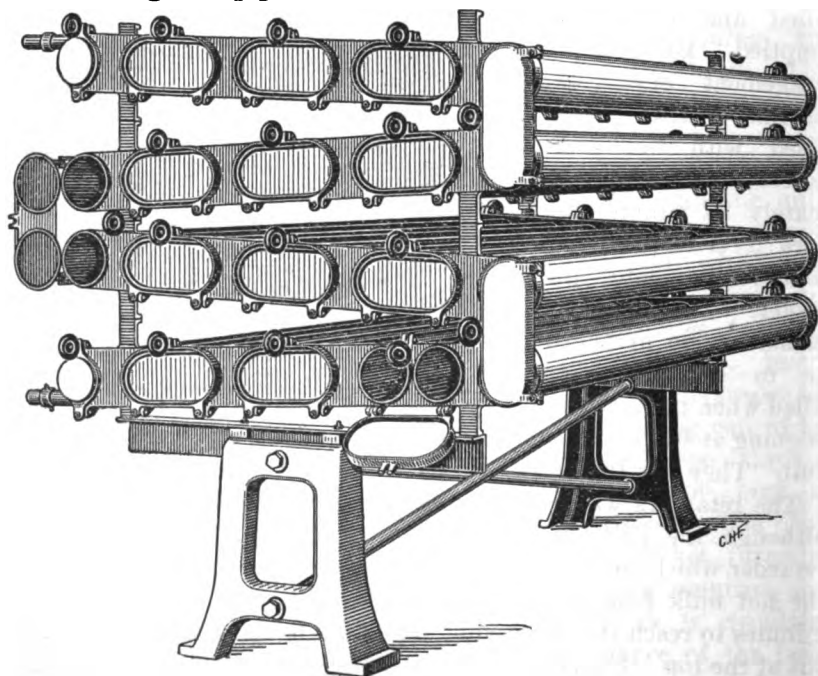


FIG. 13.—A tubular milk retarder.

compartment. As the milk reaches the top of the partition it overflows into the trough C and flows down through the pipe D to the

bottom of the second compartment. This process is repeated until all the compartments are full. When the milk has reached the top of the last compartment it overflows into the funnel B and then is conveyed to the cooler. After the milk has all been pasteurized the tank is emptied by removing the funnel B, which allows the last compartment to empty. When this is empty a plug in the bottom of the next partition is removed, which allows the milk to flow out from the adjoining compartment, and so on until the whole tank is empty. A device of this type retards the flow of milk, so that it requires 30 minutes to pass through the tank.

Figure 16 shows a third type of tank retarder. The tank is divided by a series of partitions open at the alternate ends. Milk enters at the point A and flows around the end of the partition at B, then around the end of the next partition at C, and so on through the tank to the outlet valve. The bottom of the tank on the opposite side from the outlet valve is raised, so as to permit drainage of the tank. When the tank is full of milk the float operates the outlet valve automatically.

The principal objection to holding tanks and retarders is the cost, which in the case of a small plant may be prohibitive. A very simple and cheap holding tank may be constructed from a single wall tank as shown in figure 17. If the capacity of the flash pasteurizer is 1,000 pounds an hour, a holding tank may be made by taking a 100-gallon receiving tank and dividing it by partitions into four compartments of 25 gallons each. An outlet valve should be placed in the bottom of each compartment. With a cover for the tank with milk-inlet pipes to each compartment the apparatus will be complete.

The tank may be set up with sanitary pipe connections from the pasteurizer as shown in figure 18. To operate the tank it is simply necessary to fill compartment A (fig. 17), which, with a 1,000

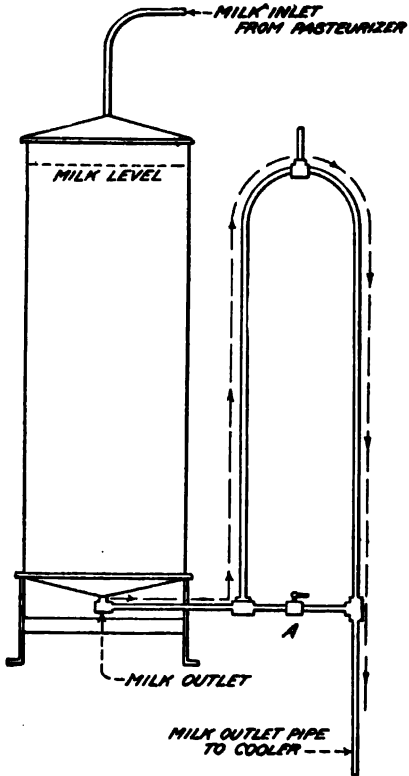


FIG. 14.—A vertical tank retarder.

pounds per hour pasteurizer, will take about 10 minutes. Then fill compartments B and C, which requires the same time for each.

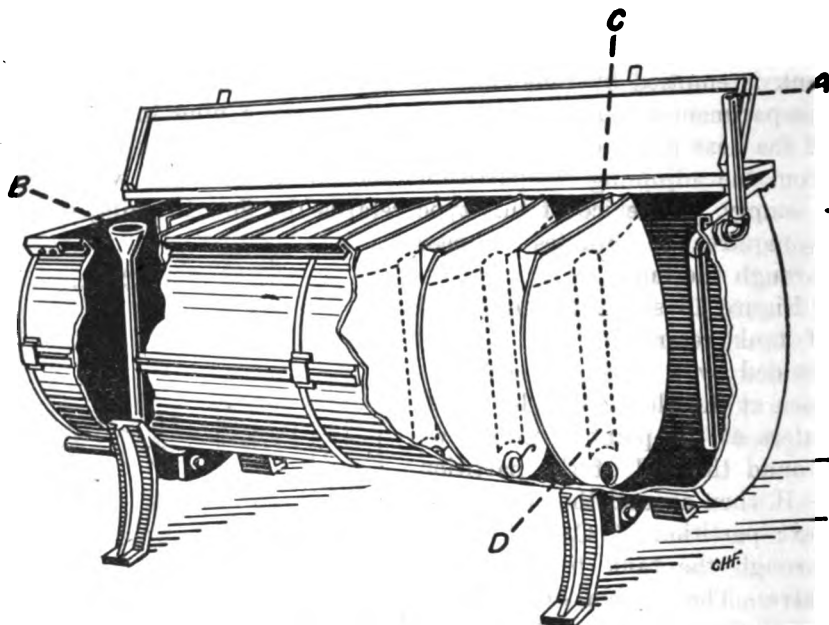


FIG. 15.—Tank retarder with compartments.

When C is full, the outlet valve of A should be opened, and, while it is emptying, compartment D should be filled. The process is

then repeated. It will be seen that by such an arrangement the milk is actually held between 20 and 30 minutes, one compartment being held during the filling of the next two.

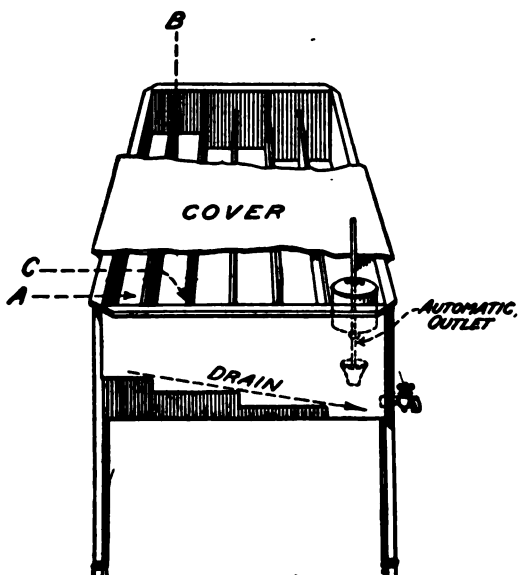


FIG. 16.—Tank retarder with automatic outlet.

automatically. To operate, start with the valves A', B', C', and D' closed. First open A', which fills compartment A. When full close

In figure 19 is shown a simple arrangement of hand control for filling and emptying the compartments. By the use of connecting bars between the handles of the valves it is only necessary to keep the tanks full of milk, as the outlet valves are operated

A' and open B' to fill B, and C' to fill C. The compartments A, B, and C are then full, and A is ready to be emptied. When valve D' is opened to fill D, the connecting bar opens valve 1, which empties A. After compartment D is filled, close valve D', and valve 1 is also closed and compartment A is empty and ready to be filled again. The valve A' is then opened to fill compartment A, and when opened outlet valve 2 is opened so that B is emptied. In this manner the

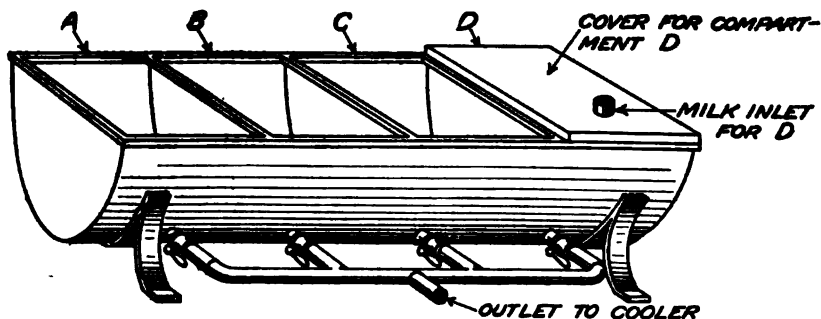


FIG. 17.—A single-wall milk tank converted into a simple holding tank.

process is continued, it being only necessary to operate the filling valves of the tank holder.

Automatic devices may be arranged to operate the filling and emptying, if it is desired, but in a small plant they are hardly necessary. By increasing the capacity of the tanks the output of pasteurizers of any capacity may be held in a similar manner as with the 1,000-pound machine.

MACHINERY FOR PASTEURIZING IN SEALED BOTTLES.

Since pasteurization of milk in sealed bottles has been advocated, some attention has been given to the

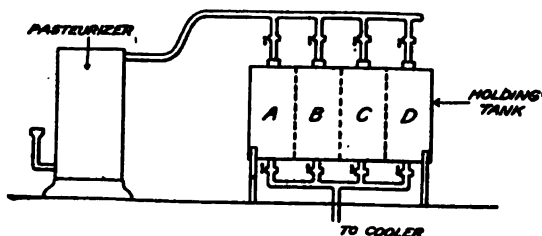


FIG. 18.—Showing method of operating tank in figure 17 with pasteurizer.

construction of suitable machinery by the manufacturers of beer-pasteurizing machines. The construction of one type of beer-pasteurizing machine which has been recommended by the manufacturers as adaptable to milk pasteurization is shown in figure 20.

The pasteurizer consists of a round tank (A) and a continuous truck (B) divided into sections of four shelves, on which trays containing bottles are placed. The truck revolves on rollers attached to the bottom of the tank. Two centrifugal pumps (J and K) lift the

water from the bottom of the tank to the water-distribution chamber N, while the spout G fills the trays with water. The water compartment in the bottom of the machine is divided into two sections, one for hot and the other for cold water, which is pumped to the water-distributing chamber N by the pumps J and K. The operation of the machine is as follows: The filled bottles are placed in trays and the latter are placed on the shelves of the revolving truck B. The truck is then started and slowly revolves, carrying the bottles

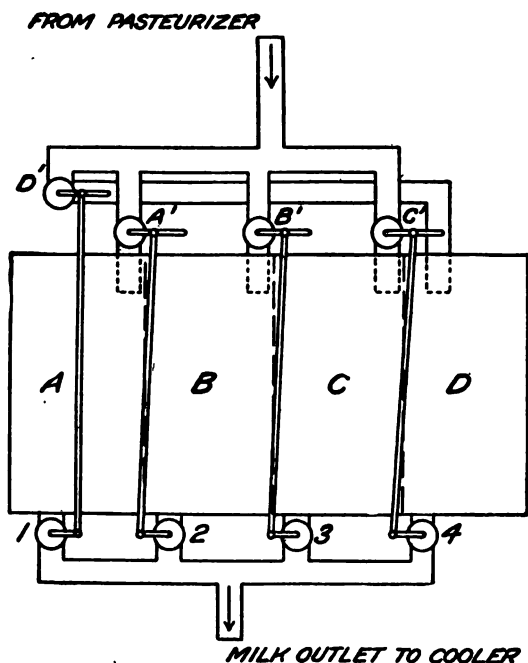


FIG. 19.—Arrangement of hand control for filling and emptying tank in figure 17.

through the warming compartment, then through the pasteurizing chamber, and from there to the cooling compartment, after which they are removed. The water-distributing pans are so arranged that a gradual mixture of hot and cold water is secured in the warming and cooling compartments. The truck makes one revolution in 1 hour and 5 minutes, which allows approximately 27 minutes' actual pasteurization. The pasteurizing compartment is maintained at a constant temperature by a thermostat.

This machine is being changed slightly in its construction so as to cool milk to a low temperature.

A similar but smaller type of machine is shown in figure 21. The pasteurizer consists of a hollow iron chest (A) with one, two, three, or four sections, according to the capacity, a water pit (B), and doors (C) at both ends. A centrifugal pump (D) is arranged so as to pump water through the pipe F to the distributing chamber G, from which it flows down through the water-distributing pan H. The tracks for trucks are designated by the letter J. K is an overflow pipe to the sewer; L is a thermostat; M, a diaphragm valve; N, steam-pressure gauge; O, air-reducing valve; P, water line and valve; Q, steam line and valve; S, air-pressure gauge; T, thermometer. The operation of the machine is as follows: The filled bottles

are placed on trucks which are rolled into the pasteurizer, the doors are closed, and the steam valve is opened and the pump started. The centrifugal pump draws the water from the pit B and forces it up through the pipe F to the water-distributing chamber G, from which it drops into the distributing pan H, and from there down over the bottles into the pit B. The process is then repeated, making a continuous flow of water, the same water being used over again and repumped about six times per minute. When the pasteurizing process begins, the water in the pit B is of normal temperature, but it is gradually heated by the steam introduced through the steam line Q. As the water gradually heats so do the contents of the bottles. When the temperature in the bottles has reached the pas-

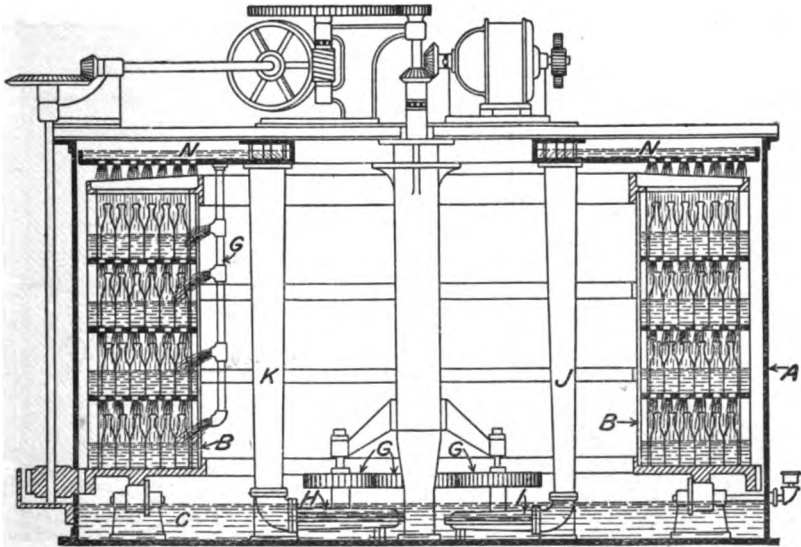


FIG. 20.—A type of beer-pasteurizing machine adaptable to the pasteurization of milk in bottles.

teurizing temperature the thermostat L acts on the air line, which in turn acts on the diaphragm valve N, automatically shutting off the steam; the water in the chamber then remains at a constant temperature, being regulated by the thermostat, which may be set for the desired temperature. When the pasteurizing temperature has been held the proper length of time, an alarm clock gives the signal and the steam is shut off. Fresh cold water is then admitted to the chamber and gradually lowers the temperature of the circulating water until the contents of the bottles have been cooled. The pump is then stopped and the trucks containing the bottles removed. This machine is equipped with brine-cooling coils, so that the contents of the bottles may be brought to a low temperature.

There are numerous types of machines on the market for the pasteurization of beer which may be used for milk, provided suitable attachments are made so as to make it possible to cool the milk to from 40° to 50° F.

Several large milk plants are experimenting at present with this process of pasteurization.

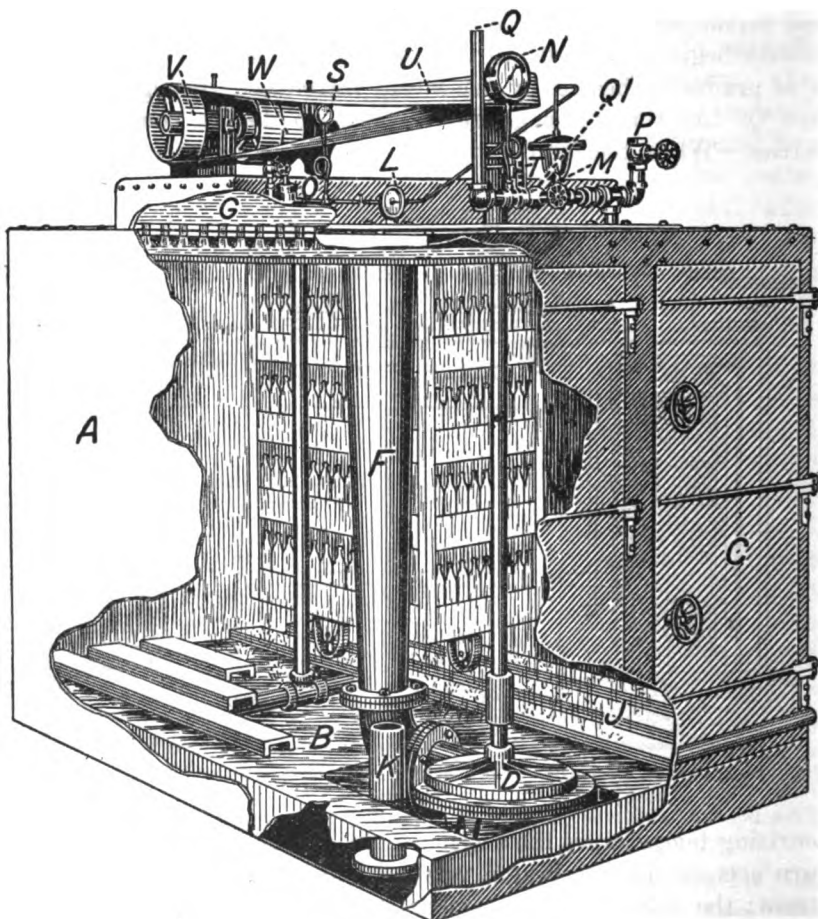


FIG. 21.—Another beer-pasteurizing machine adaptable to milk pasteurization.

COOLERS.

The simple coolers are usually arranged so that the hot milk flows down over the outside of a double corrugated surface, or a series of parallel horizontal pipes standing in a vertical position through which flows cold water and brine. Figure 22 illustrates one of the simple types of coolers. Milk which is to be cooled enters the trough at the top and is distributed by means of rows of holes in the bottom

of the trough, so that it flows in thin sheets over both sides of the corrugated surface into the trough at the bottom. Cold water flows through the upper part of the cooler and brine through the lower part.

There are other types of coolers which comprise the regenerative feature as shown in figure 23. The construction is the same as the simple pipe coolers, except that milk flows through several of the upper pipes. The arrangement is such that the cold milk to be pasteurized is pumped through a number of pipes at the top of the

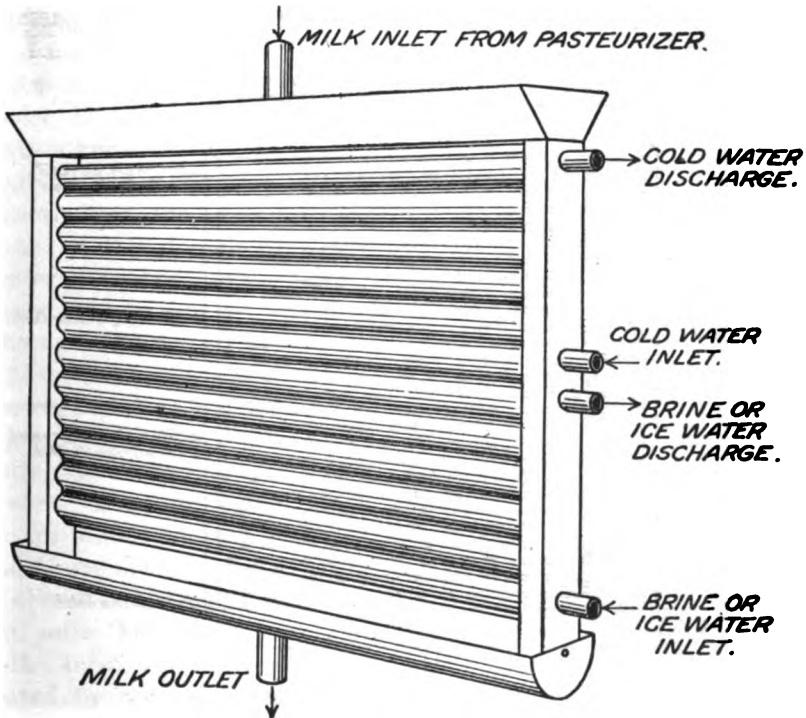


FIG. 22.—Simple type of vertical milk cooler.

cooler and is heated while cooling the hot pastuerized milk which is flowing over the outside of the pipes.

Another type of regenerative cooler is shown in a sectional view in figure 24. In this cooler the cold raw milk flows down over one side of a corrugated surface while the hot milk flows down on the other side. By such construction the cold milk is heated and the hot milk cooled.

Regenerative coolers cause a considerable saving in the cost of heating and cooling. In the selection and operation of a regenerative cooler care must be taken to see that there is no possibility of the infection of the warm pasteurized milk by the raw milk.

In connection with the simple coolers a device known as a regenerator may be used. Figure 25 shows the construction of the apparatus, which consists of four double cylinders with troughs above and below them. The cold raw milk enters the top trough and flows over the outside of the cylinders to the bottom trough, from which it is conveyed to the pasteurizer. After heating, the milk is forced back through the inside of the double cylinders, entering the lower one and leaving through the upper one, from which it flows to a simple cooler. The construction of the double cylinder is such that the milk flows in a thin layer between the wall of the outside cylinder and the surface of the inner cylinder. During the passage

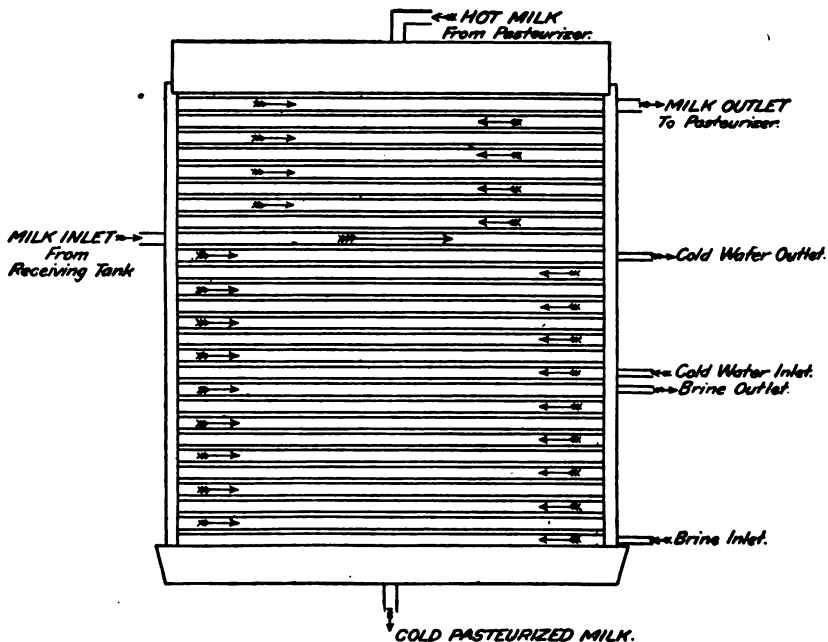


FIG. 23.—Regenerative type of milk cooler.

of the cold and hot milk the cold milk is heated and the hot milk cooled before going to the cooler. A device of this nature saves in the cost of heating and cooling, the same as a regenerative cooler.

Among the other types of coolers is the inclosed cylindrical cooler shown in figure 26. This consists of a cylindrical water jacket inside of which revolves a drum. By the centrifugal action of the revolving drum the milk is drawn over its surface and against the cold water or brine jacket; it is thus cooled and leaves the machine through the discharge pipe. These machines are also constructed so that water or brine may be circulated through the inside revolving drum, thus giving two cooling surfaces.

Figure 27 shows the side and top view of a three-compartment disk cooler which is provided with covers (not shown in the drawing). The milk is cooled by entering compartment C, where it is cooled by a series of revolving disks through which flows cold water. After compartment C is filled the milk overflows to compartment B, where it is cooled in a similar manner as in C. From B it flows to A, where it is cooled by brine flowing through the revolving disks. Sometimes two compartments only are used, one with circulating water and the other with brine. A pasteurizer of this same construction is also in use, compartment C being used for heating.

An entirely different type of cooler is shown in figure 28. This is known as the internal or double-tube cooler. The construction of the cooler is the same as the double-tube milk heater described earlier in this paper and shown in figure 6. The milk heater and coolers are arranged in figure 26 to show the regenerative water circulating system. The two sectional units A constitute the milk heater. The units B, C, D, and E are water coolers, while F and G are brine coolers. When in operation the raw milk enters the milk heater through the milk inlet and after being heated by hot water flows out to a holding tank. From the holding tank it is conveyed to the unit B, where it flows in pipes surrounded by cold water.

The milk is further cooled by cold water in units C, D, and E, and is finally cooled by brine in units F and G, from which it flows to the bottling machine. The brine flows through G and F in an opposite direction to the milk. Cold water enters two units, E and C. That which enters E flows out to the waste pipe through unit D, while that which enters C flows against the hot milk from the holding tank and while cooling it becomes heated. The water after passing through units C and B and having been partially heated is conducted to the heating units A to be used for heating the milk.

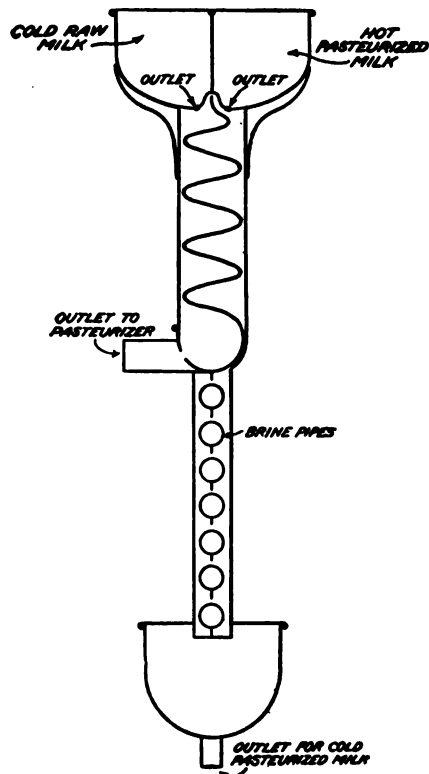


FIG. 24.—Sectional view of another type of regenerative cooler.

Before entering the heating coils the temperature is raised by a steam jet to the point necessary to heat the milk. It may be seen that by warming the water while cooling the milk, less brine is required to cool the milk and less steam to heat the water for pasteurizing.

In the selection of coolers the ease with which they may be cleaned and their efficiency must be considered. It is absolutely necessary that the coolers be inclosed or placed in a separate room which is free from dust. The uncovered simple coolers may be encased in

a frame of galvanized iron covered with tin, with doors on both sides to facilitate cleaning, and with a small glass door through which the flow of milk may be observed.

BOTTLING AND CAPPING MACHINES.

Little need be said regarding the bottling and capping machines. The various machines for this purpose are much on the same order and differ only in mechanical details. The essential feature is the accessibility of the parts. Bottles should be capped mechanically and sterilized caps should always be used.

When the size of the

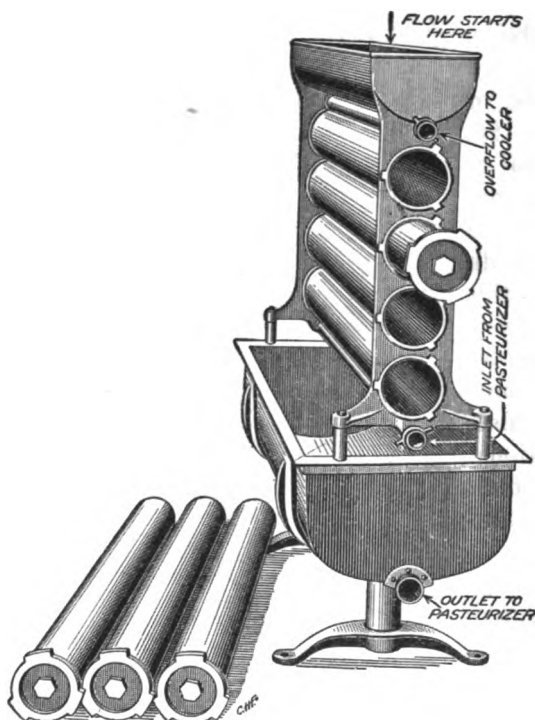


FIG. 25.—Regenerative device for use with simple cooler (three of the drums are removed and the fourth partly removed).

dairy does not warrant the purchase of an expensive automatic combination bottling and capping machine, a small simple capping machine should be used in connection with a simple bottle filler. Sterilized caps in tubes may be used with such machines. This mechanical process makes it possible to avoid the possibility of infection of the milk by employees in the plant, either from their hands or breath. Under no conditions should the hands of the employee come in contact with the milk after pasteurization, or with the inside of the milk bottles after steaming, or with the sterilized caps. This matter is of the greatest importance in the production of a sanitary product.

PASTEURIZATION ON THE FARM.

Pasteurization on the farm may be highly desirable when the farmer has a local milk route or when farm butter is manufactured. The process is inexpensive, especially when there is a small boiler on the premises, as is usually the case when bottled milk is sold. The machinery necessary for farm pasteurization is a small boiler for generating steam, which may be bought at a cost of approximately \$30, and a starter can, which costs about \$35 for a can of 30 gallons capacity. The equipment is completed with a bottling and capping machine which varies widely in cost, depending on the capacity and mechanical features. A cooler is not necessary, as the milk may be cooled in the starter can.

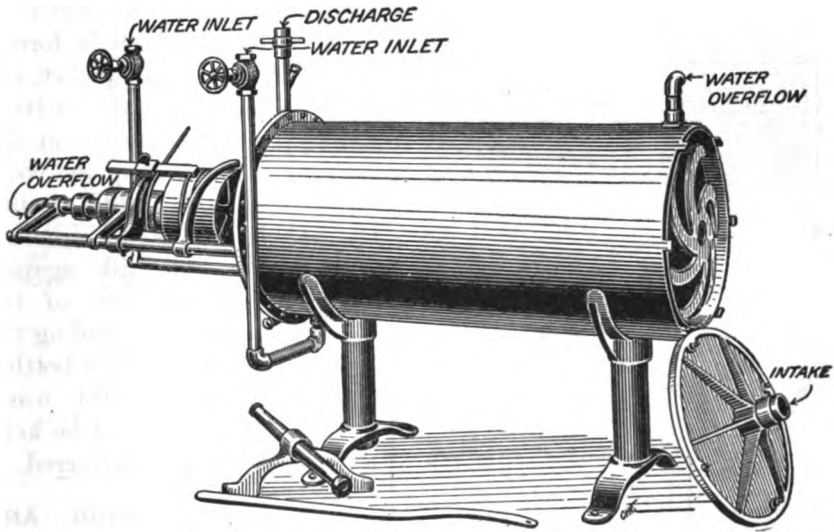


FIG. 26.—A cylindrical inclosed cooler.

The starter can is the essential part of the equipment; it is used to heat the milk, in which capacity it serves as a pasteurizer and holding tank. The starter can is a jacketed can built in various sizes up to 100 gallons capacity and used for the preparation of starters in creameries. The ordinary starter can, after having an outlet pipe placed in the bottom, makes an ideal type of small pasteurizer. Figure 29 shows the construction in detail.

The pasteurizing process may be briefly outlined as follows: The milk, directly after milking, is run into the starter can. Steam is then turned into the jacket of the can or the jacket may be filled with water and then heated by the steam. During the heating of the milk the paddles should be rotated, which may be done by hand or machinery. This circulates the milk and gives a uniform heating.

The milk should be heated to 145° F., as indicated by a thermometer which is inserted into the milk through a hole in the cover of the can. When the desired temperature is reached, which takes about 10 minutes in a 30-gallon can, the steam is turned off and the milk is allowed to stand for from 20 to 30 minutes. After that period of holding it is thoroughly pasteurized and should be cooled at once. A regular cooler may be used, but where the amount of milk is just enough to fill one starter can the cooling may be accomplished in the same can. To do this, the steam connection is unfastened and

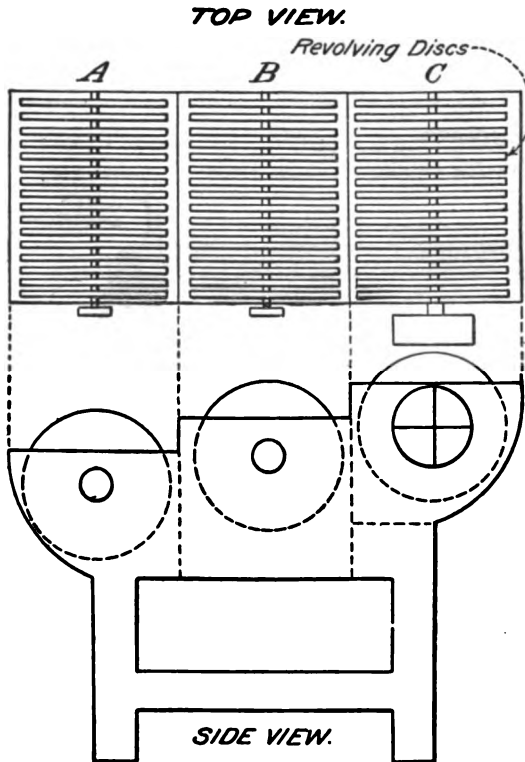


FIG. 27.—A three-compartment disk cooler.

the hot water in the jacket allowed to run out. This is replaced by cold water, followed by ice water or brine, which is forced through the jacket, entering at the bottom and flowing out at the top. During the cooling the paddle should be rotated to circulate the hot milk against the cold sides of the can. After cooling the milk should be bottled at once in the usual way and must be kept cold until delivered.

CONSTRUCTION AND ARRANGEMENT OF PASTEURIZING PLANTS.

In a plant of any size the construction of the building and location of apparatus are important. It is impossible to show any one plan of a milk plant which will be suitable for all conditions. In general it may be said that the building should be of brick or concrete. The milk rooms should have concrete floors inclined toward a drain in the center of the room. When the walls are of brick they should be covered with cement plaster, and the junction between the walls and floor should be a smooth curve instead of an angle. This construction is to allow smooth surfaces that may be washed easily and to prevent the accumulation of dirt.

Tiled walls are very satisfactory but expensive.

The milk-receiving room, pasteurizing room, and bottle-filling room should be separate whenever possible.

The selection of machinery varies with the size of the plant. Simple, inexpensive machinery may often be used in a plant pasteurizing 1,000 quarts daily, thus reducing the original cost of the plant and interest on the investment. The small plant may use one of the small, simple pasteurizers, and by running milk into a series of simple tanks, as previously described, have an inexpensive holding system of pasteurization. In the large plants more complicated and

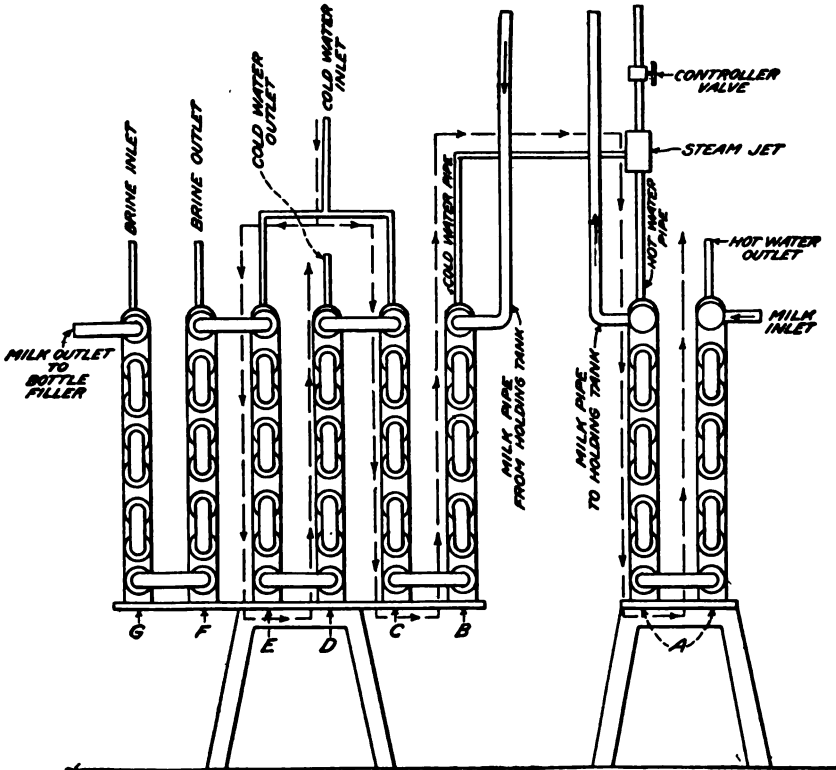


FIG. 28.—A double-tube cooler, as operated with double-tube heater shown in figure 6.

expensive machinery may be necessary on account of the amount of milk to be treated.

The location of the apparatus will depend upon the construction of the buildings. The gravity system of milk flow is the ideal one; therefore the machinery should be located whenever possible so as to avoid the use of pumps. In the gravity system the milk starts from the receiving tank and flows by gravity to the pasteurizer, from there to the holding tank—or cooler, if no holding device is used—and then to cooler and bottling machine. Such a system does away with the use of pumps, which are hard to clean. This arrangement

may be often accomplished by pumping the milk to the receiving tank at the highest level. Any milk pumps which are to be used should be placed in the system before the milk is heated and never afterwards. The piping distances should be as short as possible for reasons discussed later in this paper.

The same care of machinery and other equipment of the plant, together with sanitary conditions and methods, must be observed regardless of the size of the plant. The rooms must be kept absolutely free from flies.

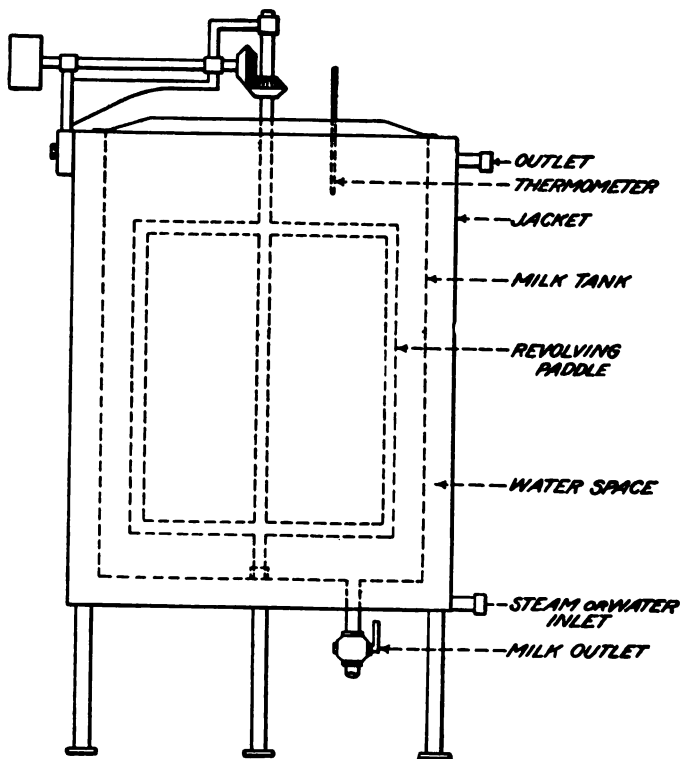


FIG. 20.—A starter can, suitable for pasteurizing on the farm.

CARE OF MACHINERY.

The most modern machinery will not give good results unless cleaned carefully and intelligent care is exercised with it. Occasionally, while the principal features of the process of pasteurization are perfect, it is found that the efficiency of the machine as determined by the percentage bacterial reduction is greatly lowered. When the same grade of milk is being pasteurized with the bacterial counts on the raw milk running evenly, and using the same temperatures for pasteurization, it may be a puzzle to the operators of the machine to determine why the efficiency varies. This may often be

attributed to improper cleaning of the machinery or apparatus in some part of the process. Let us consider a number of points where bacterial infection may take place after the milk is received at the plant:

The receiving tanks may not be clean, due to careless washing, or if thoroughly clean on previous day, dust may have settled in the tank since the washing. Obviously the bacterial content of raw milk will be greatly increased by such conditions. After being emptied of milk the tank should be rinsed out with warm water and scrubbed with some washing compound, then rinsed with hot water and steamed. Just previous to receiving the milk the tank should again be rinsed to remove dust and blown out with steam. The tanks should be covered, and at no step in the process should the milk be freely exposed to the atmosphere of the room.

At the next step in the process the separator must be cleaned in a similar way as the tanks. If cotton filters are used, see that the cotton is placed in even layers and used fresh at each pasteurization. When quartz or sand filters are used the utmost care must be taken to see that the filtering material is thoroughly washed and sterilized by steam, otherwise the bacterial content of the milk may be increased by washing out bacteria already in the filter. When properly operated these filters will remove sediment, but have little or no effect on the bacteria.

The pasteurizer when not thoroughly clean adds to the bacterial content in the same way as the other machinery. Accessibility of parts is an important factor in cleaning. The pasteurizer and holding tank should be rinsed with hot water just before using. Holding tanks should be simple in construction and have no crevices where dirt may lodge. The simple tank with spun edges is easy to clean and does not harbor dirt which may serve to contaminate the milk.

Earlier in this paper reference was made to infection of milk in coolers exposed to the open air. The bacterial content of the milk may be increased when cooling, not only by dust in the air, but also by dust on the cooler and dried milk which was left after washing.

The first milk over the cooler is always higher in bacteria than the following milk on account of having washed off the cooling surfaces. The cooler should in every case be rinsed with water and steamed just before using. The bottling and capping machine is another source of infection unless kept in a thoroughly clean condition. The valves must be given particular attention in cleaning. Pipes in milk plants are often so long and so placed that they can not be taken down to be cleaned, and complicated pumps may cause the dairyman to neglect cleaning when it is necessary. Iron pipes should never be used because the rough surfaces hold filth which is hard to remove. Only sanitary piping should be used, and that should be in

short enough sections to be easily taken down and cleaned. The various parts of pumps should be scrubbed daily with hot water and steamed.

Bacterial examinations of milk in the various steps of the process of pasteurization often reveal dirty machinery. A bacterial count of 2,000 per cubic centimeter in milk leaving the pasteurizing machine and of 40,000 per cubic centimeter in the bottled milk is not to be excused, and is entirely unnecessary, provided minor points of cleanliness are observed.

THE CLEANING OF MILK BOTTLES AND CANS.

Dirty bottles are probably the greatest source of bacterial contamination of milk after it is heated. Bottles often contain millions of bacteria after they have been washed. Washing with warm water is not enough, and even with this the water, which should be boiling or near the boiling point, more often in practice is only lukewarm. In a small plant bottles may be washed by hand, using a revolving brush operated by steam turbine, together with water near the boiling point and washing powder. In large plants a bottle-washing machine will be found useful. After washing, the bottles should be steamed. The most satisfactory way of freeing bottles from possible disease-producing organisms is by thorough washing, then inverting on trucks and steaming in a steam chamber from 20 to 30 minutes. The bottles should then remain inverted in a dustless room, free from flies, until used. If the concrete floor of the milk room is kept wet, most of the dust will be eliminated. In some cases bottles may be sterilized by steam under pressure in an autoclave. While this method is undoubtedly the best from a hygienic standpoint, it is hardly practical on a large scale, due to breakage of bottles and time consumed.

Figure 30 shows a steam chamber for steaming milk bottles. The chambers are built of heavy galvanized iron, with tight-fitting doors. The bottles to be steamed are placed inverted on trucks and run into the chamber; after closing the door, steam is admitted to the chamber through perforated pipes along the bottom. Bottles should be steamed for at least 20 minutes. A longer heating would be desirable; in fact, the longer the heating the more nearly will the bottles be free from bacteria.

Steam chambers may be constructed of brick or concrete, using iron doors. Perforated steam pipes should be placed along the bottom with the holes on top of the pipe so the jets of steam will be directed upward. A pipe should be placed in the top of the chamber to allow steam to escape. This will avoid creating steam pressure in the chamber, which might blow the doors off. Steam chambers of this type have been found to be very satisfactory.

This method of steaming bottles in a steam chamber is ideal, but is often impossible when large numbers of bottles have to be handled on account of the time consumed by the process. It is possible, however, to get practically as good results by steaming the bottles for two or three minutes. This short steaming may be accomplished by

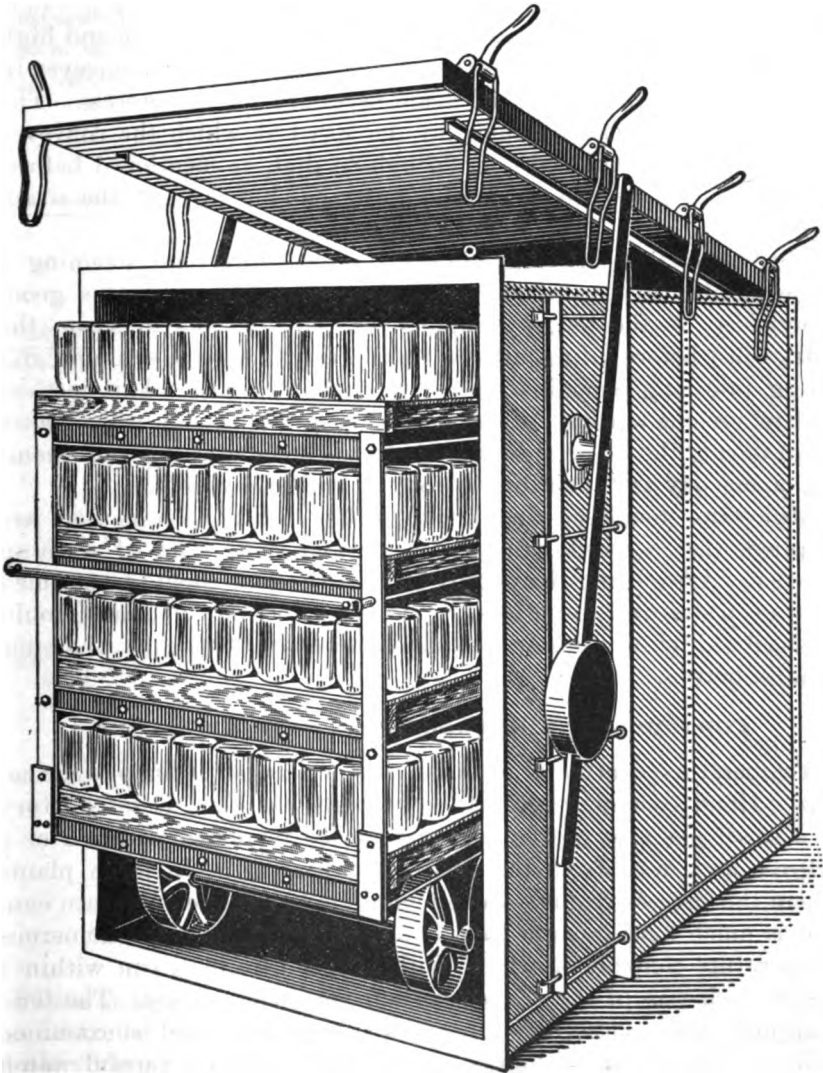


FIG. 30.—Steam chamber, showing method of steaming bottles.

placing the bottles, inverted, in crates on a mechanical conveyer, which carries them through a steam chamber of sufficient size so that the bottles are in the chamber for two or three minutes. The chamber may be made by simply inclosing a part of the conveyer in a galvanized-iron structure, with open ends, so as to allow the crates

of bottles to pass in one end and out the other. Steam should be admitted to the chamber through perforated pipes which run along under the conveyer. The steam will then be blown directly into the inverted bottles while at the same time the chamber is kept full of steam. The bottom of the chamber should be fitted with a waste pipe for condensed steam and so inclined as to carry off the water. When a chamber of this type is used, it should be just wide and high enough to allow a crate of bottles to pass through on the conveyer in order to reduce the amount of steam necessary for the process. The length can be determined only by the speed at which the conveyer is moving, but should be long enough so that, as mentioned before, the bottles will be two or three minutes passing through the steam chamber.

This method of steaming affords a rapid process for steaming a large number of bottles and will give results which are as good, practically, as the longer steaming. It is advisable to steam the bottles just before filling, allowing an interval between steaming and filling just long enough to allow the bottle to cool. This method will reduce the amount of contamination of the bottles, which takes place during the interval of storage between the washing and steaming on one day and the filling with milk on the next day.

Milk cans should be rinsed with cold water as soon as they are emptied, then washed with hot water and some kind of washing powder. After being thoroughly cleaned the cans should be steamed over a can sterilizer for at least two minutes. If possible, cans should be sterilized by steaming in a steam chamber for 20 minutes, the same as milk bottles.

CONTROLLING THE PROCESS OF PASTEURIZATION.

Temperature control is the most important factor in pasteurization. Hand control, when left to a competent man, is satisfactory in a small plant, as the temperature can be regulated within 2 or 3 degrees each way from the desired temperature. In large plants where the process requires some hours, mechanical temperature control is much more certain than hand control. There are numerous temperature controllers, which, with proper care, will run within 1 degree each way of the desired pasteurizing temperature. The temperatures should be recorded in a locked box and should be examined daily by the person in charge of the plant. With a careful watch on the temperature and cleanliness of the apparatus a good product may be assured.

In figure 31 is shown an automatic system of temperature control together with a recording thermometer. The underlying principle of the automatic control is the regulation of the steam flow by a diaphragm valve. The valve is operated by air pressure regulated by

expansion and contraction in the controller bulb, which is inserted in the milk outlet of the pasteurizer. Any temperature desired may be obtained by setting the controller. The bulb of the recording thermometer is inserted in the milk as it leaves the pasteurizer and records the temperature on a chart as is shown in figure 32. This shows the temperature record during pasteurization by the holder process from 7.45 a. m. to about 11.45 a. m. The chart shows that the temperature thus recorded was about 145° F.

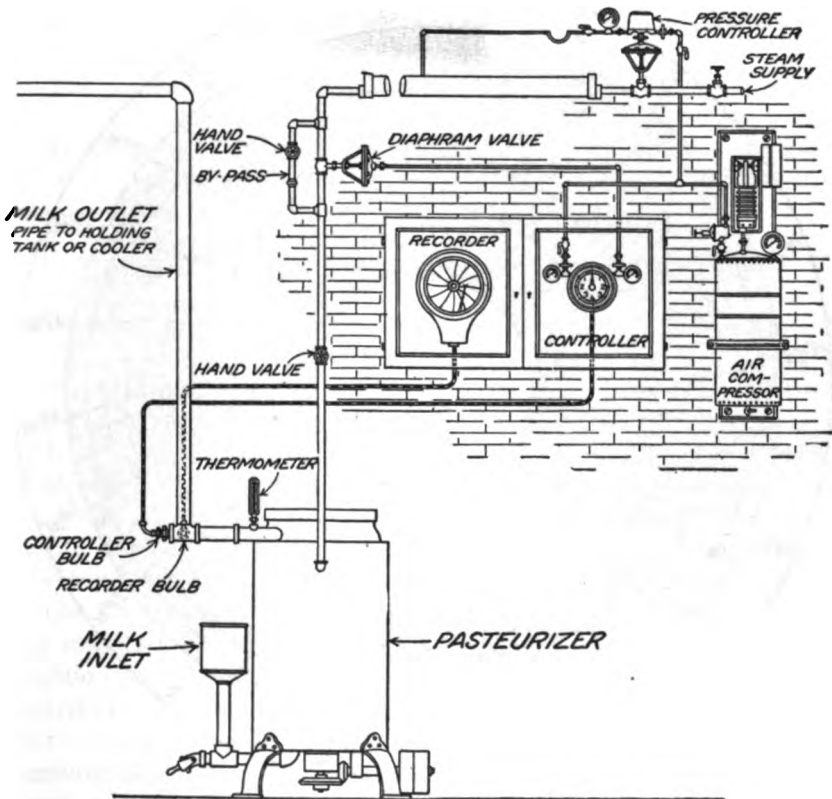


FIG. 31.—An automatic system of temperature control.

When using these automatic devices, care must be taken to see that the controller and recorder bulbs are not exposed to escaping steam or placed against hot surfaces. In other words, they must be affected only by the milk in order to get the correct temperature.

Whenever possible, a bacteriological laboratory should be maintained. The bacterial counts should be made on litmus-lactose-gelatin plates, incubated at 18° C. (64.4° F.) for six days. This medium seems to be the most useful, as it enables one to make a differential count of the bacteria. For the simple determination of the number

of bacteria plain infusion agar may be used. Bacterial examinations should be made daily of the raw milk and of the finished product. At frequent intervals the milk should be examined at various steps in the process to check up the cleaning of the machinery and apparatus. Examinations should also often be made of the bottles, and the number of bacteria in them determined. This is important, since the reinfection of pasteurized milk may be largely attributed to

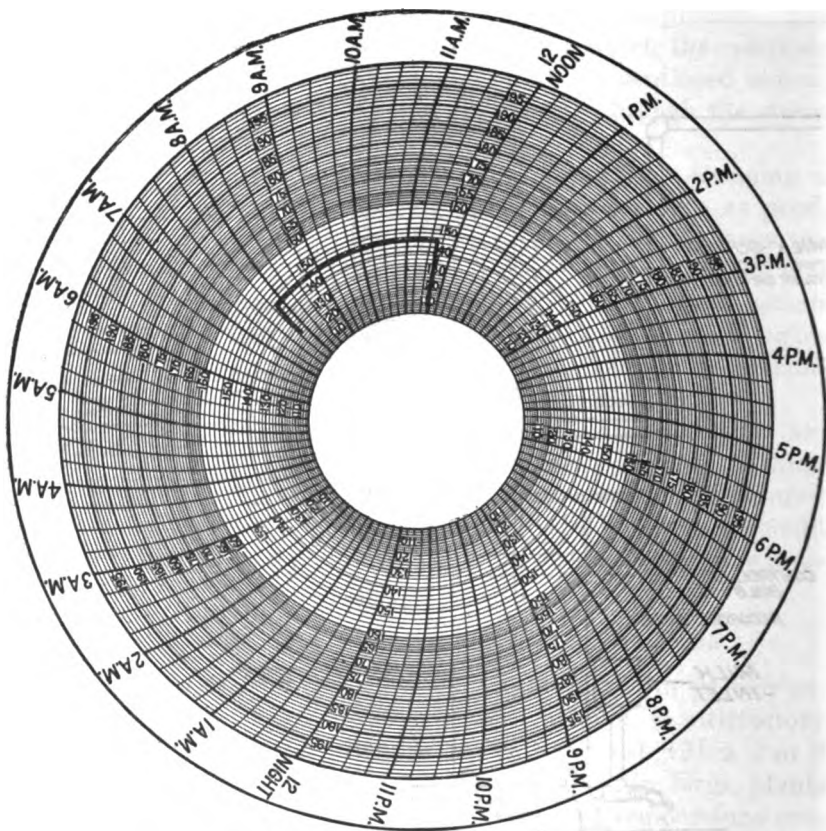


FIG. 32.—Temperature chart, showing temperature recorded during pasteurization (holder process) from 7.45 a. m. to 11.35 a. m.

dirty bottles. The value of bacteriological examinations can not be too highly estimated in the control of pasteurization.

TEMPERATURES AND METHODS TO BE USED.

It is essential to use an accurate thermometer when heating milk. Many of the ordinary thermometers may register a number of degrees away from the correct reading, so the thermometer in use should be tested against a thermometer known to be correct.

As previously stated, the best method of pasteurization at the present time, and the one which should be used, is the holder process, in which the milk is held for 30 minutes. For this process a temperature of 145° F. is to be advised, since that temperature gives a margin beyond that sufficient to destroy pathogenic organisms, while at the same time it leaves in the milk the maximum number of lactic-acid-producing organisms which cause the souring of the milk. When using the flash process, the milk should be heated to at least 160° F. Since there is almost always a fluctuation in the temperature during pasteurization, care should be taken to see that the temperature never drops below 160° F. in the flash process.

The pasteurization of milk in bottles may, in the future, prove to be the best method when suitable machinery is devised for the process.

If the process of bottling pasteurized milk while hot proves satisfactory on a commercial scale, it will undoubtedly be an important improvement on the present system of pasteurizing milk.

HANDLING AND DELIVERY OF PASTEURIZED MILK.

Milk after pasteurization should be cooled as rapidly as possible to 40° F. and kept at that temperature until delivery. During the warm weather it should be iced on the delivery wagons. From a sanitary standpoint all milk, whether raw or pasteurized, should be delivered as soon as possible in order to get it to the consumer in the best condition. In the best pasteurized milk there is only a slight bacterial increase when held on ice during the first 24 hours, yet in many cases the pasteurization and delivery may be so arranged that the consumer may get the milk before any change in the bacterial content has taken place. The cream line is, of course, regarded as an essential feature in market milk since at the present time the public demands it. It is not necessary, however, to hold milk pasteurized one morning until the next in order to get the cream line, for two or three hours' refrigeration is sufficient to get the full amount of cream. The tops of the bottles should be protected from dust, dirt, or other contamination by an overlapping cap, by a paper cover held in place by a rubber band, or by some of the patent secondary caps now on the market. The milk should be marked "pasteurized," with the date and temperature of the process. This information should be printed on the caps for the benefit of the consumer, as it is only right that he should know whether he is using raw or pasteurized milk, and if pasteurized the temperature may be of importance to him. Some people object to using pasteurized milk, especially for infant feeding, while others desire it. It has been the experience of numerous milk dealers that the labeling of their product has greatly increased their trade.

As any grade of milk deteriorates quickly even when placed in the refrigerator consumers should be advised to use milk within 24 hours after delivery and to keep it cold during that time. They should also be advised to provide small insulated boxes in which the delivery man can place the cold milk bottles in warm weather. Very often in the summer months milk is delivered at 2 or 3 o'clock in the morning and is exposed to the sun from sunrise until 6 or 7 o'clock, or later. During that time the temperature of the milk rises and the bacteria increase rapidly. The use of tight insulated boxes will help to keep the milk cold, provided it is iced on the wagons.

The progressive milk dealer would do well to advertise the fact that his milk is produced in a sanitary milk plant and by the most sanitary methods. He should fix a high standard and maintain it for his own benefit as well as his customers.

ADDITIONAL COPIES of this publication
may be procured from the SUPERINTEND-
ENT OF DOCUMENTS, Government Printing
Office, Washington, D. C., at 5 cents per copy



